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CONTENTS

LIST OF ILLUSTRATIONS

PLATES

TEXT FIGURES

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AFRICAN REPTILES AND AMPHIBIANS IN FIELD MUSEUM OF NATURAL HISTORY

BY

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CONTENTS

AFRICAN REPTILES AND AMPHIBIANS
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INTRODUCTION

The African herpetological collections of Field Museum may be said to have started with twenty-two specimens brought back by D. G. Elliot and Carl E. Akeley from British Somaliland in 1896. Although most of these were referable to common and widespread species, *Coluber rhodorachis* and *Philochortus hardeggeri* were taken. Neither of these can be considered anything but rare in museums.

During the years 1905–07, Akeley again visited Africa. He was accompanied by Edmund Heller and together they collected in the region now known as Kenya Colony. Two hundred and nineteen reptiles and thirty-eight amphibians were secured, among them the type series of *Agama agama caudospinosa* and a pair of the diminutive snake *Vipera hindii*.

In 1925–26, Heller passed through Kenya to Uganda, where he collected in the zoologically little-known Kigezi District and across the border in Belgian Ruanda-Urundi and the Belgian Congo. On this trip he secured 209 reptiles and 972 amphibians, the richest herpetological results obtained by any of Field Museum's African expeditions. Apart from new races based on this material, the rarities obtained by Mr. Heller are too numerous to list here; of outstanding importance, however, are *Cnemaspis dickersoni*, *Hemidactylus ituriensis*, and *Algyroides boulengeri*.

About the same time, i.e. in 1926, J. T. Zimmer was engaged on an ornithological reconnaissance which took him through Tanganyika Territory, the eastern Belgian Congo and Uganda. Mr. Zimmer, in addition to his avian studies, found time to gather 279 reptiles and amphibians. Among these was an exceedingly rare file snake, *Mehelya chanleri*, and a choice arboreal lizard, *Holaspis guentheri*. The capture of the latter fills me with envy for it was obtained at Uleia, only two days' march south of Kilosa, where I spent two years without seeing one.

It was also in 1926 that W. H. Osgood, accompanied by A. M. Bailey and the late Louis A. Fuertes, visited Ethiopia. Prior to this expedition there were only six reptiles from Ethiopia in Field

Museum. As a result of this trip, fifty-three specimens were added, including the holotype of a very distinct toad, *Bufo osgoodi*, and examples of *Aeluroglena cucullata* and *Mocquardia obscura*, representing two genera of which I believe no other specimens exist in any American collection.[1] In 1929, C. J. Albrecht secured fourteen more reptiles and eight amphibians from Ethiopia, so the Field Museum collection is relatively rich in material from this neglected region. Mr. W. D. Hambly, while engaged in anthropological studies for Field Museum in Angola, collected seventy-six specimens of amphibians and reptiles.

The foregoing briefly summarizes the more important herpetological collections made by members of the museum staff in Africa. Were these all, the material would be preponderantly eastern and unrepresentative, but steps were taken by purchase and exchange to secure a well-balanced series. Thus Morocco is represented by ten specimens from the Riggenbach collections and Algeria by two from the British Museum. By exchange forty-five examples of Egyptian reptiles were obtained, as well as nine collected by the famous Ruwenzori Expedition to the Mountains of the Moon.

From Cape Colony there are eighty-one reptiles and amphibians, collected by A. S. Romer and F. C. Wecke; six specimens from the Southwest Protectorate include *Palmatogecko rangei* and *Aporosaura anchietae*, taken by J. Gaerdes. One of the most valuable collections consists of eighty-two reptiles and amphibians from Cameroon and Gaboon, representative of the West African fauna, which were purchased from W. F. H. Rosenberg in 1923. These are supplemented by eight amphibia collected by Mrs. Edwin Cozzens, including a series of *Rana goliath*, and *Astylosternus robustus*, the so-called "hairy frog" of Africa. From Nigeria there are three specimens, contributed by Miss E. A. Clark and Mr. William Heckman.

Only a few small and unimportant accessions are omitted from this summary, but enough has been said to show that the collection is reasonably representative. It is weakest in material from Africa west of the Cameroons and from the vast Sudan, and it would be desirable to augment the collection from these areas.

This report deals only with the African collections of Field Museum up to December 31, 1931, at which time there were 941 reptiles and 1,241 amphibians. Since then the Museum has been

[1] Since this was written the Museum of Comparative Zoology has received five examples of *M. abyssinica* from Addis Ababa.

greatly enriched by the receipt of its share of the splendid material resulting from the Vernay-Lang Kalahari Expedition. The herpetological results of this expedition have been reported upon elsewhere by Mr. V. Fitzsimons of the Transvaal Museum (Ann. Transvaal Mus., **15**, pp. 25 40 and pp. 519-550, 1932 and 1935). My thanks are due to Mr. Karl P. Schmidt, curator of the herpetological collections in Field Museum, for his unfailing kindness and helpfulness in answering questions, comparing material, and otherwise aiding the production and publication of the report.

SUMMARY OF TAXONOMIC CHANGES

Only two papers dealing with the African herpetological collections of Field Museum have appeared so far. Both were by the late S. E. Meek (Field Mus., Zool. Ser., **1**, pp. 175 184, 1897; ibid, **7**, pp. 403 414, 1910), and it should be borne in mind that at the time they were written Dr. Meek was dependent on the literature, with no comparative material available. Even so, their appearance was unfortunate, more particularly the first, in which every lizard was misidentified and all the "new" forms were synonyms of well-known species. The most useful purpose this earlier publication can serve is as a warning to those contemplating publication with an inadequate knowledge of the literature or without comparative material.

It seems advisable to publish the identifications which I have made after a careful re-examination of Dr. Meek's material. In the paper dealing with Akeley's collection from British Somaliland, Meek lists seventeen species of which ten were incorrectly determined as follows:

Psammophis sibilans = *Psammophis biseriatus* Peters
Varanus albigularis = *Varanus ocellatus* Heyden
Latastia carinata = *Philochortus hardeggeri* (Steindachner)
Eremias brenneri = *Eremias mucronata* (Blanford)
Mabuia varia = *Mabuya striata* (Peters)
Lygosoma (sic) *akeleyi* = *Chalcides o. ocellatus* (Forskal)
Rhampholeon mandera = *Rhampholeon k. robecchi* Boulenger
Bufo garmani = *Bufo r. regularis* Reuss
Bufo viridis somalicus = *Bufo blanfordii* Boulenger
Phrynobatrachus hailiensis = *Rana oxyrhynchus* A. Smith

In the paper on Akeley's British East African material only eleven of the forty-four species listed are subject to correction. The first two should not be considered errors as the races were described subsequent to the appearance of the paper.

Testudo pardalis = *Testudo pardalis babcocki* Loveridge
Trimerorhinus tritaeniatus = *Trimerorhinus t. multisquamis* Loveridge
Rhamphiophis oxyrhynchus = *Rhamphiophis rostratus* Peters
Psammophis sibilans = *Psammophis subtaeniatus* Peters

Causus resimus=*Causus rhombeatus* (Lichtenstein)
Hemidactylus brookii= *Hemidactylus mabouia* (M. de Jonnès)
Agama colonorum=*Agama a. lionotus* Boulenger
Chamaeleon ellioti=*Chamaeleon b. bitaeniatus* Fischer
Chamaeleon dilepis=*Chamaeleon d. roperi* Boulenger and
C. b. höhnelii Steindachner
Rana mascariensis Gunther (sic)=*Rana m. mascareniensis* D. and B. and *R. oxyrhynchus* A. Smith
Rappia marmorata (Rapp) = *Hyperolius striolatus* Peters
Rappia cinctiventris (Cope)= *Hyperolius striolatus* Peters

Further references to synonymy, which result from the study of the collection as a whole, are the following:

Typhlops batesii Boulenger=*Typhlops steinhausi* Werner
Mizodon variegatus Peters=*Natrix fuliginoides* (Gunther)
Simocephalus butleri Boulenger=*Mehelya chanleri* (Stejneger)
Simocephalus unicolor Boulenger=*Mehelya chanleri* (Stejneger)
Mehelya somaliensis Lonnberg and Andersson=*Mehelya chanleri* (Stejneger)
Chlorophis schubotzi Sternfeld=*Chlorophis emini* (Gunther)
Chlorophis heterodermus pobeguini Chabanaud=*Chlorophis heterodermus* Hallowell
Chlorophis cyaneus Hecht=*Chlorophis heterodermus* Hallowell
Euprepes raddoni Gray=*Mabuya blandingii* (Hallowell)
Mabuya varia var. *longiloba* Methuen and Hewitt=*Mabuya varia damaranus* (Peters)
Chalcides pulchellus Mocquard=*Chalcides b. bottegi* Boulenger
Chamaeleon jacksoni var. *vauereseccae* Tornier=*Chamaeleon jacksoni* Boulenger
Gampsosteonyx batesii Boulenger=*Astylosternus diadematus* Werner
Astylosternus oxyrhynchus Nieden=*Scotobleps gabonicus* Boulenger
Rana (Tomopterna) signata Ahl=*R. delalandii cryptotis* Boulenger
Rana (Tomopterna) cacondana Ahl=*R. delalandii cryptotis* Boulenger
Rana unagralli Scortecci=*R. galamensis bravana* (Peters)
Rana fiechteri Scortecci=*R. galamensis bravana* (Peters)
Rana somalica Scortecci=*R. galamensis bravana* (Peters)
Phrynobatrachus versicolor Ahl=*Phrynobatrachus dendrobates* (Boulenger)
Phrynobatrachus petropedetoides Ahl=*Phrynobatrachus dendrobates* (Boulenger)
Leptopelis rugegensis Ahl=*Leptopelis karissimbensis* Ahl
Rothschildia kounhiensis Mocquard=*Mocquardia obscura* (Boulenger)
Phrynomantis nasuta Methuen & Hewitt=*Phrynomerus annectens* (Werner)
Hoplophryne marmorata Ahl=*Phrynomerus annectens* (Werner)

LOCALITIES FROM WHICH MATERIAL IS RECORDED

ALGERIA

Algiers. Capital and chief port of the country.

El Kantara. Southeast of Algiers 200 miles.

ANGOLA

Benguela (Benguella). The well-known port on the west coast, 12° 30′ S., 13° 20′ E.

Cabiri. A few miles west of St. Paul de Loanda.

Cuma. District of Huambo, Province of Benguela.

Dondo (Ndondo). On the Quanza River southeast of St. Paul de Loanda.

BELGIAN CONGO

Bambuni. At the western base of the Ruwenzori Range.

Beni. This is old Beni, a well-known post in the Semliki Valley just north of Lake Edward.

Bugongo Ridge. On the western watershed of the Ruwenzori Range. Alt. 9,500 feet.

Bukama. Between, and a little to the east of Lakes Edward and Kivu; close to the former western corner of the boundary between Uganda and former German East Africa.

Bunia. Forty miles northeast of Irumu, which see.

Ibala. On Musongi Creek on the western watershed of the Ruwenzori Range. Alt. 7,000 feet.

Irumu. A little west of the south end of Lake Albert.

Kabengere. On the Luapula River, which flows from Lake Bangweulu to Lake Mweru.

Kalongi Village. On the western watershed of the Ruwenzori Range. Alt. 8,500 feet.

Katobwe. On the upper Lualaba River, about sixty miles north of Bukama.

Kivu, Lake. Due north of Lake Tanganyika. Its western half lies in the Congo but the eastern portion is in Belgian Ruanda-Urundi.

Mambawanga Hill. Forty miles west of Beni, which see.

Ruchuru (Rutschuru). An important government post midway between Lakes Edward and Kivu.

Walikale. A government post seventy-five miles due west of the extreme northwest corner of Lake Kivu.

BELGIAN RUANDA-URUNDI

Kisenji (Kissenji, and also Kissegnies in Wollaston, 1908, "From Ruwenzori to the Belgian Congo"). An important government post on the northeast shore of Lake Kivu.

Kivu, Lake. Due north of Lake Tanganyika. Heller collected both on the Congo and Ruanda shores of this beautiful lake.

BRITISH SOMALILAND. *See* SOMALILAND PROTECTORATE

CAMEROON

Akok. A coastal town near Kribi at the mouth of the Kribi River, southern Cameroon.

Batan. Possibly an abbreviation or error for Batanga, which see.

Batanga. Either Little or Great Batanga lying to the north and south of Kribi on the coast.

Bitye. On the Ja River.

Efulen. About seventy-five miles southeast of Lolodorf, 2° 40′ N., 10° 45′ E.

Ja River (Dscha River). About seventy-five miles east of Kribi.

Kribi River. Discharges into the Atlantic Ocean at Kribi, southeast of Fernando Po.

Lolodorf. On the Lokundu River, fifty miles inland from Little Batanga.

Cape Province, Union of South Africa

Bechuanaland. An area of Cape Province lying to the north of Griqualand and the Orange River, south of the Bechuanaland Protectorate and west of the Transvaal.

Lady Frere. A few miles northeast of Queenstown and about a hundred miles northwest of East London.

Kleinzee. Near Port Nolloth, which see.

Port Elizabeth. In Algoa Bay midway between Cape Town and Durban.

Port Nolloth. Near the boundary of the Southwest African Protectorate and about 500 miles due northwest of Cape Town.

Egypt

Alexandria. The large Egyptian port.

Cairo. Capital and chief city of Egypt; 30° 10′ N., 31° 10′ E.

Giza (Gizeh). A suburb of Cairo, which see.

Karnak. Near Luxor, lower Nile.

Suez and Ismailia. Ismailia lies halfway between Port Said and Suez on the Suez Canal. Suez is at the southeastern entrance of the Canal.

Tel el Amarna. On the Nile 175 miles south of Cairo.

Ethiopia (Abyssinia)

As these Ethiopian localities are on few maps, the latitude and longitude are given. The spelling adopted, except in the case of the Webi Shebeli, is that of the Times "Map of Abyssinia" revised in 1935. I am indebted to Dr. W. H. Osgood for defining or assisting in locating many of these places.

Addis Ababa. Capital and chief town of Ethiopia, also terminus of the railway from Jibuti, French Somaliland; 9° 4′ N., 38° 50′ E.

Albasso Mountain. An elevated region at the northeastern end of the Chilalo Range, Arusi Province; 7° 50′ N., 39° 30′ E.

Allata. Former capital of Sidamo Province, northeast of Lake Abaya; 6° 33′ N., 38° 28′ E.

Awadi River. A small stream flowing into Lake Shala from the east. Arusi Province.

Bisan River. In Sidamo Province, near Boran country.

Chilalo Mountains. Arusi Province, southeast of Lake Zwai; 7° 44′ N., 39° 24′ E.

Derark. Village northeast of Gondar near the base of Simien Mountains; 13° 8′ N., 37° 55′ E.

Dungulbar. Village on west side of Lake Tana, Gojjam Province; 11° 58′ N., 37° 2′ E.

Gatelo (Gatalo). Southeast of Lake Abaya in Sidamo Province; 5° 57′ N., 38° 12′ E.

Gedeb Mountains. Near Dodolo on south side of upper Webi Shebeli River in Bale District; 6° 55′ N., 39° 10′ E.

Gendoa River. A tributary of the Atbara River flowing northwest to the Sudan border, Dembea Province; 12° 30′ N., 36° 30′ E.

Gondar. Well-known town a few miles north of Lake Tana; 12° 34′ N., 37° 31′ E.

Harar (Harrar). An important town southeast of Diredawa and about 100 miles southeast of Jibuti; 9° 15′ N., 42° 10′ E.

Harsi Barri. In Ogaden district near boundary of British Somaliland about 200 miles southeast of Harar.

Haud. Elevated country along the British Somaliland border about 200 miles due south of Berbera.

Metemma. Ethiopian village at Sudan border opposite Gallabat; 12° 58′ N., 36° 10′ E.

Shala, Lake. A Rift Valley lake, about 100 miles south, slightly southwest, of Addis Ababa; 7° 25′ N., 38° 30′ E.

Sheik Hussein. South side of Webi Shebeli River about 100 miles south of Awash railway station; 7° 38′ N., 40° 43′ E.

Tana (Tsana), *Lake*. In Amhara Province about 500 miles due south of Suakin and 400 miles west of Jibuti; 12° N., 37° 15′ E.

Webi Shebeli River. A well-known river rising in western Arusi and flowing east and southeast through broken foothills to Italian Somaliland.

Zegi. On Lake Tana, which see.

FRENCH CONGO

Abanga River. A confluent of the Ogowe River in the Gaboon District.

Fan Topat. On the Ogowe River.

Lambarene. On the Ogowe River about 100 miles due east of Cape Lopez.

Ngama. On the Ogowe River.

KENYA COLONY

Aberdare Mountains. A range of mountains about halfway between Lake Naivasha and Mount Kenya. Summits said to be 11,000–12,000 feet.

Athi Plains. North and east of Nairobi.

Elmenteita, Lake. Near Elmenteita Station (6,012 feet) on the Kenya-Uganda Railway between Naivasha and Nakuru.

Gilgil. Between Naivasha and Nakuru. Alt. 6,581 feet.

Kenya, Mount. Situated about 135 miles north of Nairobi. Alt. 17,040 feet.

Kijabe. Kijabe Station is on the Kenya-Uganda Railway between Nairobi and Naivasha. Alt. 6,787 feet.

Lagari. Mau District, south of Elburgon Range, west of the Rift Valley.

Lukenya Hills. On the Athi Plains east of Nairobi. Also spelled Alucania, Ulucania, Ulukenia, Lukenya, etc.

Machakos. Close to Ulu Station (5,252 feet) on the Kenya-Uganda Railway, approximately 30 miles southeast of Nairobi. Alt. about 5,000 feet.

Molo. A station on the Kenya-Uganda Railway between Nakuru and Londiani. Alt. 8,064 feet.

Nairobi. Capital of the colony with station on the railway 327 miles from Mombasa and 260 miles from Kisumu. Alt. 5,452 feet.

Naivasha. A station on the Kenya-Uganda Railway close to the famous lake from which it takes its name. Alt. 6,231 feet.

Tsavo. A station on the Kenya-Uganda Railway 136 miles northwest of Mombasa. Alt. 1,525 feet.

Voi. A station on the Kenya-Uganda Railway 103 miles northwest of Mombasa. Alt. 1,834 feet.

MOROCCO

Atlas Mountains. The well-known range running approximately east and west across the country.

Mogador. Principal seaport on the west coast, lying northeast of the Canary Islands.

NIGERIA

Agberi. On the Niger River in southern Nigeria, about seventy-five miles from the mouth of the river.

Marama. Not located.

Zungeru. An important town in northern Nigeria, in the Niger Province.

SOMALILAND PROTECTORATE

Berbera. Chief port and capital town, lying due south of and opposite Aden, Arabia.

Betteran. About halfway between Berbera and Laferug.

Durban. About twenty miles east of Berbera, near the coast.

Halleh. Thirty miles southeast of Berbera, at the foot of the Golis Mountains.

Hullieh (Hullier). A few miles southeast of Hargeisa.

Mandera. At base of Golis Mountains, near Jerato Pass.

Sheik. In the Golis (Goolis) Mountains. It is the seat of Government and connected by fifty miles of motor road with Berbera. Rainfall 11.7 inches per annum. Alt. 4,500 feet.

Toyo Plain. South of Berbera 150 miles, in the Haud.

SOUTHWEST PROTECTORATE (GERMAN SOUTHWEST AFRICA)

Namib Desert. Coastal region of Southwest Africa.

SPANISH GUINEA

Benito River. Principal river of Spanish Guinea.

SUDAN

Durrur (Dooroor). Near Suakin, which see.

Suakin. The old port on the Red Sea, now superseded by Port Sudan, which lies a little north of Suakin.

Wadi Halfa. On the Nile near the northern border of the Anglo-Egyptian Sudan.

TANGANYIKA TERRITORY (GERMAN EAST AFRICA)

Dodoma. Chief town of Ugogo and the Central Province. On the Central Railway about 260 miles west of Dar es Salaam. Alt. 3,890 feet.

Kitete. Mahenge District.

Mahenge. Chief town of Mahenge District. Situated about 140 miles due south of Kilosa on the Central Railway.

Manka, Lake. Seven miles south of Mkomazi Station on the Tanga-Moshi line and thirty miles northwest of Mombo Station.

Matameras. Mahenge District.

Mitiangu. Mahenge District.

Mnazi. At the northern foot of the western Usambara Mountains, forty miles due north of Lushoto.

Uleia. A native village on the Kilosa-Iringa Road twenty miles south of Kilosa on the Central Railway.

Ulambo. Mahenge District.

UGANDA

Bihunga (Behungi). On the eastern slopes of the Ruwenzori Mountains. Alt. 8,300 feet.

Budu (Buddu) shore. The northwestern shore of Lake Victoria in the Budu District.

Bulukutoni. On the road from Rhino Camp to Arua. Alt. 2,500 feet.

Bunyoni, Lake. In extreme southwestern Uganda.

Kigezi District. In the southwestern corner of the Western Province.

Kisolo. In the Kigezi District, which see.

Northern Province. Lying between the West Nile Province and the Eastern Province.

Rhino Camp. On the west bank of the Nile at 2° 55′ N., in the West Nile Province (former Lado Enclave).

Ruwenzori Mountains. Lying between Lakes Albert and Edward in the Western Province and on the Uganda-Congo border. Maximum alt. 16,794 feet.

Sabinio, Mount. One of the Kivu volcanoes which lies partly in Uganda and partly in Belgian territory. Alt. 8,500 feet.

Sese Islands. A group of islands in the northwest corner of Lake Victoria but southwest from Entebbe.

White Nile District. The region lying between Lake Albert and Nimule on the Uganda-Sudan border.

LIST OF SPECIES IN FIELD MUSEUM

(*signifies a type or paratype series)

Class REPTILIA

Order TESTUDINATA

Family TESTUDINIDAE

Testudo pardalis babcocki Loveridge
Testudo tornieri Siebenrock
Kinixys belliana Gray

Family PELOMEDUSIDAE

Pelusios sinuatus (Smith)
Pelomedusa galeata (Schoepff)

Order SQUAMATA

Family TYPHLOPIDAE

Typhlops punctatus punctatus (Leach)
Typhlops steinhausi Werner

Family BOIDAE

Python sebae (Gmelin)

Family COLUBRIDAE

Subfamily COLUBRINAE

Natrix fuliginoides (Gunther)
Natrix olivacea olivacea (Peters)
Natrix viperina (Latreille)
Bothrolycus ater Gunther
Pseudoboodon lemniscatus (Duméril and Bibron)
Boaedon guttatus (Smith)
Boaedon lineatus Duméril and Bibron
Boaedon olivaceus (A. Duméril)
Lycophidion capense capense (Smith)
Lycophidion fasciatum (Gunther)
Mehelya chanleri chanleri (Stejneger)
Pseudaspis cana (Linnaeus)
Coluber rhodorachis (Jan)
Coluber florulentulus Geoffroy
Coluber hippocrepis Linnaeus
Aeluroglena cucullata Boulenger
Chlorophis carinatus Andersson
Chlorophis heterodermus Hallowell
Chlorophis neglectus (Peters)
Chlorophis irregularis (Leach)
Philothamnus semivariegatus semivariegatus (Smith)
Gastropyxis smaragdina (Schlegel)
Hapsidophrys lineata Fischer
Coronella semiornata semiornata Peters
Grayia tholloni Mocquard
Grayia ornata (Bocage)
Duberria lutrix shiranum (Boulenger)

Subfamily DASYPELTINAE

Dasypeltis scaber (Linnaeus)

Subfamily BOIGINAE

Boiga pulverulenta (Fischer)
Dipsadoboa unicolor Günther
Crotaphopeltis hotamboeia hotamboeia (Laurenti)
Amplorhinus nototaenia (Günther)
Malpolon monspessulanus monspessulanus (Hermann)
**Trimerorhinus tritaeniatus multisquamis* Loveridge
Rhamphiophis rostratus Peters
Dromophis lineatus (Duméril and Bibron)
Psammophis subtaeniatus Peters
Psammophis sibilans (Linnaeus)
Psammophis furcatus Peters
Psammophis biseriatus Peters
Psammophis crucifer (Daudin)
Macroprotodon cucullatus (Geoffroy)
Thelotornis kirtlandii (Hallowell)
Dispholidus typus (Smith)
Miodon gabonensis (Duméril)
Elapops modestus Günther

Subfamily ELAPINAE

Elapsoidea güntherii Bocage
Naja melanoleuca Hallowell
Naja nigricollis nigricollis Reinhardt
Naja goldii Boulenger
Elaps lacteus (Linnaeus)
Dendraspis jamesoni kaimosae Loveridge
Dendraspis angusticeps (Smith)

Family VIPERIDAE

Causus rhombeatus (Lichtenstein)
Causus resimus (Peters)
Causus lichtensteinii (Jan)
Vipera hindii Boulenger
Bitis arietans (Merrem)
Bitis gabonica (Duméril and Bibron)
Bitis nasicornis (Shaw)
Bitis cornuta (Daudin)
Bitis caudalis (Smith)
Echis carinatus (Schneider)
Atheris squamigera (Hallowell)
Atheris nitschei Tornier
Atractaspis bibronii Smith
Atractaspis microlepidota Günther

Suborder LACERTILIA

Family GEKKONIDAE

Hemitheconyx caudicinctus (Duméril)
Stenodactylus sthenodactylus sthenodactylus (Lichtenstein)
Palmatogecko rangei Andersson
Gymnodactylus trachyblepharus Boettger
Cnemaspis dickersoni (Schmidt)
Hemidactylus mabouia (Moreau de Jonnès)
Hemidactylus fasciatus Gray
Hemidactylus ituriensis Schmidt
Hemidactylus sinaitus Boulenger
Hemidactylus brookii Gray
Lygodactylus picturatus picturatus (Peters)
Lygodactylus picturatus gutturalis (Bocage)
Tarentola mauritanica mauritanica (Linnaeus)
Tarentola annularis (Geoffroy)
Pachydactylus mariquensis Smith
Pachydactylus austeni Hewitt

Family AGAMIDAE

Agama mutabilis Merrem
Agama flavimaculata (Rüppell)
Agama pallida Reuss
Agama hispida brachyura Boulenger
Agama hispida aculeata Merrem
Agama atra atra Daudin
Agama mossambica montana Barbour and Loveridge
Agama agama agama (Linnaeus)
Agama agama subsp.
Agama agama lionotus Boulenger
**Agama agama usambarae* Barbour & Loveridge
Agama planiceps planiceps Peters
**Agama planiceps caudospinosa* Meek
Agama atricollis Smith
Agama cyanogaster (Rüppell)
Uromastix ocellatus Lichtenstein

Family ZONURIDAE

Zonurus macropholis Boulenger
Zonurus cordylus cordylus (Linnaeus)

Family VARANIDAE

Varanus albigularis angolensis Schmidt
Varanus ocellatus Heyden
Varanus niloticus (Linnaeus)

Family LACERTIDAE

Lacerta jacksoni Boulenger
Algiroides boulengeri Peracca
Latastia l. longicaudata (Reuss)
Latastia longicaudata revoili (Vaillant)
Philochortus hardeggeri (Steindachner)
Acanthodactylus pardalis pardalis (Lichtenstein)
Acanthodactylus boskianus asper (Audouin)
Acanthodactylus scutellatus scutellatus (Audouin)
Eremias spekii spekii Günther
Eremias mucronata (Blanford)
Eremias guttulata guttulata (Lichtenstein)
Eremias rubropunctata (Lichtenstein)
Eremias lineo-ocellata Duméril and Bibron
Scapteira reticulata Bocage
Scapteira ctenodactyla (Smith)
Aporosaura anchietae (Bocage)
Holaspis guentheri Gray

Family GERRHOSAURIDAE

Gerrhosaurus major major Duméril
Gerrhosaurus major zechi Tornier
Gerrhosaurus f. flavigularis Wiegmann
Gerrhosaurus f. nigrolineatus Hallowell

Family SCINCIDAE

Mabuya maculilabris (Gray)
Mabuya polytropis Boulenger
Mabuya blandingii (Hallowell)
Mabuya brevicollis (Wiegmann)
Mabuya megalura (Peters)
Mabuya quinquetaeniata obsti Werner
Mabuya quinquetaeniata quinquetaeniata (Lichtenstein)
Mabuya varia varia (Peters)
Mabuya varia damaranus (Peters)
Mabuya striata (Peters)
Emoia breviceps (Peters)
Riopa fernandi (Burton)
Riopa sundevallii (Smith)
Siaphos graueri graueri (Sternfeld)
**Siaphos meleagris helleri* Loveridge
Ablepharus wahlbergii (Smith)
Scincus scincus scincus (Linnaeus)
Chalcides ocellatus ocellatus (Forskål)
Chalcides ocellatus tiligugu (Gmelin)
Chalcides bottegi bottegi Boulenger
Chalcides bottegi thierryi Tornier
Chalcides delislii Boulenger
Chalcides sepoides (Audouin)
Scelotes bipes (Linnaeus)
Feylinia currori currori Gray
Typhlosaurus meyeri Boettger
Typhlosaurus vermis Boulenger

Suborder RHIPTOGLOSSA

Family CHAMAELEONTIDAE

Chamaeleon chamaeleon (Linnaeus)
Chamaeleon basiliscus Cope
Chamaeleon senegalensis Daudin
Chamaeleon gracilis gracilis Hallowell
Chamaeleon dilepis dilepis Leach
Chamaeleon dilepis roperi Boulenger
Chamaeleon b. bitaeniatus Fischer
Chamaeleon b. ellioti Günther
Chamaeleon b. rudis Boulenger
Chamaeleon b. höhnelii Steindachner
Chamaeleon pumilus Daudin
Chamaeleon affinis Gray
Chamaeleon namaquensis Smith
Chamaeleon cristatus Stutchbury
Chamaeleon jacksoni Boulenger
Chamaeleon johnstoni Boulenger
**Rhampholeon kerstenii robecchii* Boulenger
Rhampholeon spectrum (Buchholz)

Class AMPHIBIA

Order ECAUDATA

Family PIPIDAE

**Xenopus laevis bunyoniensis* Loveridge
Xenopus laevis victorianus Ahl

Family BUFONIDAE

**Bufo regularis kisoloensis* Loveridge
Bufo regularis regularis Reuss
Bufo camerunensis camerunensis Parker
Bufo funereus Bocage
Bufo tuberosus Günther
Bufo gariepensis gariepensis Smith
Bufo superciliaris Boulenger
Bufo carens Smith
Bufo blanfordii Boulenger
**Bufo osgoodi* Loveridge
Nectophryne afra Buchholz and Peters

Family RANIDAE

Scotobleps gabonicus Boulenger
Trichobatrachus robustus Boulenger
Astylosternus diadematus Werner
Rana goliath Boulenger
Rana crassipes Buchholz and Peters
Rana subsigillata Duméril
Rana occipitalis Günther
Rana delalandii delalandii (Duméril and Bibron)
Rana fuscigula angolensis Bocage
Rana cooperi Parker
Rana aequiplicata Werner
**Rana oxyrhynchus* Smith
Rana mascareniensis mascareniensis Duméril and Bibron
Rana m. uzungwensis Loveridge
Rana mascareniensis subsp.
Rana mascareniensis venusta Werner
Rana ansorgii Boulenger
Rana galamensis bravana (Peters)
Rana albolabris Hallowell
Petropedetes newtonii (Bocage)
Phrynobatrachus natalensis (Smith)
Phrynobatrachus graueri (Nieden)
Phrynobatrachus dendrobates (Boulenger)
Phrynobatrachus plicatus (Günther)
Phrynobatrachus acridoides (Cope)
Arthroleptis variabilis Matschie
Arthroleptis poecilonotus Peters
Arthroleptis minutus Boulenger
Arthroleptis ogoensis Boulenger
Arthroleptis rouxi Nieden
Hemisus marmoratum marmoratum (Peters)

Family POLYPEDATIDAE

Chiromantis rufescens (Günther)
Leptopelis bocagii (Günther)
Leptopelis brevirostris (Werner)
Leptopelis palmatus (Peters)
Leptopelis aubryi (Duméril)
Leptopelis ocellatus (Mocquard)
Leptopelis karissimbensis Ahl
Megalixalus fornasinii (Bianconi)
Megalixalus dorsalis (Peters)
Megalixalus leptosomus (Peters)
Hyperolius spp.
Hyperolius steindachneri Bocage
Hyperolius ocellatus Günther
Hyperolius concolor (Hallowell)
Hyperolius pleurotaenius (Boulenger)
Hyperolius picturatus Peters
Hyperolius kivuensis Ahl
Hyperolius multicolor Ahl
Hyperolius graueri Ahl
Hyperolius argentovittis Ahl
Hyperolius decoratus Ahl
Hyperolius punctulatus (Bocage)
Hyperolius striolatus Peters
Hyperolius undulatus (Boulenger)
Hyperolius simus Ahl
Hyperolius cinnamome-ventris Bocage
Hyperolius nasutus Günther
Mocquardia obscura (Boulenger)
Kassina senegalensis (Duméril and Bibron)

Family BREVICIPITIDAE

Breviceps adspersus Peters
Phrynomerus bifasciatus (Smith)
Phrynomerus annectens (Werner)

TESTUDINIDAE

Testudo pardalis babcocki Loveridge.

Testudo pardalis Meek, Field Mus., Zool. Ser., 1, p. 184, 1897 (not of Bell).

Testudo pardalis babcocki Loveridge, Bull. Mus. Comp. Zool., 79, p. 4, 1935—Mount Debasien, Karamoja, Kenya Colony, 5,500 feet.

1 (2778): Southwest Mount Kenya, Kenya Colony (Akeley, 1906).

1 (2779): Kenya Colony (Akeley, 1906).

The specimen from Toyo plain, collected by Akeley in 1896, has not been traced.

Testudo tornieri Siebenrock.

Testudo tornieri Siebenrock, Sitzber. Akad. Wiss. Wien, Math.-Nat. Kl., **24**, p. 185, 1903 Bussisi (i.e. Rusisi), Belgian Ruanda-Urundi.

Testudo (Malacochersus) tornieri Lindholm, Zool. Anz., Leipzig, **81**, p. 285, 1929.

4 (5616–9): Dodoma, Tanganyika Territory (Loveridge, 1921).

Kinixys belliana Gray.

Kinixys belliana Gray, Synopsis Rept., p. 69, 1831 -habitat unknown.

Cinixys belliana Boulenger, Cat. Chel. Brit. Mus., p. 143, 1889; Meek, Field Mus., Zool. Ser., **7**, p. 414, 1910.

1 (2272): Athi Plains, Kenya Colony (Akeley, 1906).

Though several races of *belliana* have been proposed by Hewitt, trinomials are not employed until there are more substantial grounds of proof that these races are not based on individual variations.

PELOMEDUSIDAE

Pelusios sinuatus (Smith).

Sternothaerus sinuatus Smith, Illus. Zool. S. Africa, **3**, pl. 1, 1838—South Africa "in rivers to the north of 25 S. latitude"; Boulenger, Cat. Chel. Brit. Mus., p. 194, 1889.

1 (1780): Kenya Colony (Akeley, 1906).

Pelomedusa galeata (Schoepff).

Testudo galeata Schoepff, Hist. Testud., p. 12, pl. 3, fig. 1, 1792— "Habitat in India orientale, Carolina."

Pelomedusa galeata Boulenger, Cat. Chel. Brit. Mus., p. 194, 1889; Meek, Field Mus., Zool. Ser., **7**, p. 414, 1910.

1 (2273): Lukenya Hills, Kenya Colony (Akeley, 1906).

TYPHLOPIDAE

Typhlops punctatus punctatus (Leach).

Acontias punctatus Leach, in Bowdich, Miss. Ashantee, p. 493, 1819— Fantee, Gold Coast.

Typhlops punctatus Boulenger, Cat. Snakes Brit. Mus., **1**, p. 42, 1893.

1 (4034): Kribi River, Cameroon (Bates).

Midbody scale-rows 28. Total length 245 mm. Diameter 9 mm. Diameter included in the length 27 times.

Trinomials are used, as in the outlying rain forests of the Usambara and Uluguru Mountains in East Africa there occurs a well-marked

race (*gierrai*) with occasional intermediates. The Kribi specimen is of the color form *congestus*, which cannot be considered either as a race or as a distinct species.

Typhlops steinhausi Werner.

Typhlops steinhausi Werner, Jahrb. Hamb. Wiss. Anst., 26, p. 209, 1909 Cameroon.

Typhlops batesii Boulenger, Ann. Mag. Nat. Hist., (8), 8, p. 370, 1911 - Bitye, Cameroon.

1 (4035): Kribi River, Cameroon (Bates).

Midbody scale-rows 26. Total length 305 mm. Diameter 8 mm. Diameter included in the length 38 times.

This specimen has been compared with M.C.Z. 8242 from Lolodorf, Cameroon, previously identified as *steinhausi;* the latter has midbody scale-rows 26. Total length 365 mm. Diameter 9 mm. Diameter included in the length 40 times. In Werner's two cotypes the diameter was included from 41 to 45 times. Werner compares *steinhausi* with *elegans*. It is undoubtedly more closely related to *punctatus* from which it is to be distinguished only by its more elongate form and in possessing a preocular which is a trifle narrower than that of *punctatus*. For example, specimens of *punctatus* of 300 and 365 mm. have midbody diameters of 9 and 13 mm. respectively; this results in the diameter being included in the total length 23 to 28 times as against 38 to 49 times in *steinhausi* of the same size. This greater slenderness of *steinhausi* is immediately noticeable when a snake of that species is placed with a series of *punctatus*.

In 1915 the Museum of Comparative Zoology received from W. F. H. Rosenberg, of London, a topotype of *T. batesii* collected by Bates and in all probability identified by Boulenger. In looking up the description of *batesii* I find that Boulenger compared it with *punctatus*. He states "eyes hidden," while of *steinhausi* Werner wrote "eyes scarcely distinguishable." Elsewhere (Loveridge, 1933, p. 214) I have shown the fallaciousness of this character. Our specimen (M.C.Z. 11294) has: Midbody scale-rows 26, total length 394 (385+9) mm., diameter 8 mm.; diameter included in the length 49 times. Boulenger's types were from 39 to 40 times.

BOIDAE

Python sebae (Gmelin).

Coluber sebae Gmelin, Syst. Nat., 1, p. 1118, 1788 - no type locality.
Python sebae Boulenger, Cat. Snakes Brit. Mus., 1, p. 86, 1893.

1 (12843): Ruchuru, Belgian Congo (Heller, 1925).

1 (12972): Kabengere, Belgian Congo (Zimmer, 1926).

1 (13121): Rhino Camp, Uganda (Zimmer, 1926).

These specimens have been identified by K. P. Schmidt and have not been examined by the author.

COLUBRIDAE (COLUBRINAE)

Natrix fuliginoides (Günther).

Coronella fuliginoides Günther, Cat. Snakes Brit. Mus., p. 39, 1858 West Africa.

Mizodon variegatus Peters, Monatsb. Akad. Wiss. Berlin, p. 358, 1861—Gold Coast.

Tropidonotus fuliginoides Boulenger, Cat. Snakes Brit. Mus., 1, p. 217, 1893.

1 (4030): Efulen, Cameroon (Bates).

3 (4031-3): Bitye, Cameroon (Bates).

Midbody scale-rows 15–17; ventrals 125-130; anal entire or divided; subcaudals 66–85; labials 7-8, fourth and fifth entering the orbit except on the right side of the head in Number 4033 where the fourth only enters; preoculars 2; postoculars 3; there is a wide variability in the relative length of the anterior and posterior chin-shields though the posterior are always the longer; the longest are one and two-thirds times the length of the anterior. Largest specimen measures 424 (294+130) mm.

On the basis of the variability of the Bitye series I have no hesitation in assigning *variegatus* (15 midbody scale-rows) to the synonymy of *fuliginoides* (17 midbody scale-rows); both types occur at Bitye and their coloration is identical.

Natrix olivacea olivacea (Peters).

Coronella olivacea Peters, Monatsb. Akad. Wiss. Berlin, p. 622, 1854—Tete, Mozambique.

Tropidonotus olivaceus Boulenger, Cat. Snakes Brit. Mus., 1, p. 227, 1893.

1 (12987): Kabengere, Belgian Congo (Zimmer, 1926).

Midbody scale-rows 19; ventrals 140; anal divided; subcaudals?; labials 8, fourth and fifth entering the orbit. A broad, dark, vertebral band; the lateral pigmentation encroaches on the edges of the ventrals.

Natrix viperina (Latreille).

Coluber viperinus Latreille, Hist. Nat. Rept., 4, p. 49, pl., 1802—near Brive, Dept. Correze, France (restricted).

Tropidonotus viperinus Boulenger, Cat. Snakes Brit. Mus., 1, p. 235, 1893.

3 (4039–41): Atlas Mountains, Morocco (Riggenbach).

Midbody scale-rows 21–23; ventrals 158–159; anal divided; subcaudals 56–66; labials 7, third and fourth entering the orbit. Largest specimen measures 438 (356+82) mm.

Bothrolycus ater Günther.

Bothrolycus ater Günther, Proc. Zool. Soc. Lond., p. 444, pl. lvii, fig. B, 1874 Cameroon; Boulenger, Cat. Snakes Brit. Mus., 1, p. 326, 1893.

2 (4001–2): Ja River, Cameroon (Bates).

Midbody scale-rows 17; ventrals 140–143; anal entire; caudals 31–32; labials 7, third, fourth, and fifth entering the orbit. Larger snake measures 416 (355+61) mm. The top of the head and nape of the younger snake is cream-colored in striking contrast to the white-flecked, black head of the adult.

Pseudoboodon lemniscatus (Duméril and Bibron).

Boaedon lemniscatum Duméril and Bibron, Erpét. Gén., 7, p. 365, 1854 Abyssinia (Ethiopia).

Boodon lemniscatus Boulenger, Cat. Snakes Brit. Mus., 1, p. 329, 1893.

Pseudoboodon gascae Peracca, Boll. Mus. Torin, 12, No. 273, p. 1, 1897 Maldi, Eritrea.

Lamprophis abyssinicus Mocquard, Bull. Mus. Paris, 12, p. 249, 1906 Akaki, Ethiopia.

1 (12526): Chilalo Mountains, Ethiopia (Osgood, 1926).

Midbody scale-rows 23; ventrals 206; anal entire; subcaudals 43; labials 8, third, fourth, and fifth entering the orbit; preocular 1; postoculars 2; temporals 1+2. Total length 805 (707+98) mm.

Boaedon guttatus (Smith).

Lycodon guttatus A. Smith, Illus. Zool. S. Africa, 3, pl. xxiii, 1843 beyond Kurrichane, Cape Colony.

Boodon guttatus Boulenger, Cat. Snakes Brit. Mus., 1, p. 331, 1893.

1 (16036): Kleinzee, Cape Province (Wecke, 1931).

Midbody scale-rows 21; ventrals 195; anal entire; subcaudals 62; labials 8, third, fourth, and fifth entering the orbit; postoculars 2. Total length 205 (167+38) mm.

Boaedon lineatus Duméril and Bibron.

Boaedon lineatus Duméril and Bibron, Erpét. Gén., 7, p. 363, 1854 Gold Coast.

Boodon lineatus Boulenger, Cat. Snakes Brit. Mus., 1, p. 332, 1893.

1 (3997): Ruwenzori Mountains, Uganda (Ruwenzori Expedition, 1906).

1 (3998): Cabiri, Angola (Ansorge).

1 (6976): Bunia, Belgian Congo (Heller, 1924).

3 (8980–1, 9883): Kisolo, Uganda (Heller, 1926).

6 (9906–8, 9916–7, 9920): Lake Bunyoni, Uganda (Heller, 1926).

6 (12826–31): Mambawanga, Belgian Congo (Heller, 1926).

7 (12844–9, 12851): Ruchuru, Belgian Congo (Heller, 1925).

1 (12897): Katobwe, Belgian Congo (Zimmer, 1926).

1 (12907): Kabengere, Belgian Congo (Zimmer, 1926).

1 (13128): Rhino Camp, Uganda (Zimmer, 1926).

Midbody scale-rows 27–31; ventrals 204–239; anal entire; subcaudals 43–67; labials 8–9, fourth and fifth, in all except No. 8981 where it is the fifth and sixth on one side, entering the orbit; postoculars 2; in many specimens both pairs of chin-shields are well separated on the median line, usually 2 pairs though frequently a third and fourth pair; in such cases it is difficult to draw the line as to what should be regarded as chin-shields and what as paired elongated scales; parietal shields always longer than the distance between the frontal and the end of the snout. Largest specimen (3997) measures 934 (801+133) mm.

In the stomach of the Kabengere snake is a multimammate mouse (*Mastomys coucha* subsp.) identified by Dr. Glover M. Allen.

Boaedon olivaceus (Duméril).

Holuropholis olivaceus Duméril, Rev. Mag. Zool., p. 466, 1856—Gaboon.

Boodon olivaceus Boulenger, Cat. Snakes Brit. Mus., 1, p. 335, 1893.

2 (3999–4000): Ja River, Cameroon (Bates).

1 (12850): Ruchuru, Belgian Congo (Heller, 1925).

Midbody scale-rows 29; ventrals 202–214; anal entire; subcaudals 38–44; labials 8, third, fourth, and fifth entering the orbit (Cameroon) or fourth and fifth (Congo). Largest specimen measures 742 (655 +87) mm.

Lycophidion capense capense (Smith).

Lycodon capensis Smith, South Afr. Quart. Journ., 1, No. 5, p. 18, 1831—beyond Kurrichane about 25° S. Lat., Cape Colony.

Lycophidium capense Boulenger, Cat. Snakes Brit. Mus., 1, p. 339, 1893; Meek, Field Mus. Nat. Hist., Zool. Ser., 7, p. 405, 1910.

1 (2430): Nairobi, Kenya Colony (Akeley, 1905–7).

1 (4026): Harar, Ethiopia (Kristensen).

1 (4027): Belgian Congo (Delhage).

1 (12314): Uleia, Tanganyika Territory (Zimmer, 1927).

1 (12842): Ruchuru, Belgian Congo (Zimmer, 1925).

Midbody scale-rows 17; ventrals 176-203; anal entire; subcaudals 32-43; labials 8, third, fourth, and fifth entering the orbit except on No. 4026 where the third, fourth, fifth, and sixth enter on the right side, the fourth, fifth, and sixth on the left. Largest specimen measures 399 (360+39) mm.

Unfortunately the body of the Uleia snake is missing but as this village is only a few miles south of Kilosa I would suggest that it is an intermediate between *c. capense* and *c. acutirostre* with a low ventral count. It has the dark throat of *acutirostre* but so have the Harar and Ruchuru snakes.

It seems doubtful whether *L. abyssinicum* Boulenger is recognizable; the only character in which it differs from *capense* appears to be that its rostral is but little broader than deep instead of being twice as broad as deep as in *capense*. In this character the Harar specimen certainly does not differ from typical *capense*.

Lycophidion fasciatum (Günther).

Alopecion fasciatum Günther, Cat. Snakes Brit. Mus., p. 196, 1858 West Africa.

Lycophidium fasciatum Boulenger, Cat. Snakes Brit. Mus., 1, p. 342, 1893.

2 (4028-9): Ja River, Cameroon (Bates).

Midbody scale-rows 17; ventrals 176-179; anal entire; subcaudals 43-43; labials 7, third, fourth, and fifth entering the orbit. Larger specimen, a female, measures 368 (315+53) mm.

The gullet of the smaller snake is distended with an unbroken egg, whether of bird or lizard it would be hard to say; apparently there are others in its stomach.

Mehelya chanleri chanleri (Stejneger).

Simocephalus chanleri Stejneger, Proc. U. S. Nat. Mus., 16, p. 726, 1893 Wange, coast of Kenya Colony (*not* on Manda Island).

Simocephalus butleri Boulenger, Ann. Mag. Nat. Hist., (7), 20, p. 489, 1907—between Wau and Chak Chak, Bahr el Ghazel, Sudan.

Simocephalus unicolor Boulenger, Ann. Mag. Nat. Hist., (8), 5, p. 512, 1910 Fort Hall, Kenya Colony.

Mehelya (Simocephalus) somaliensis Lönnberg and Andersson, Ark. Zool., 8, No. 20, p. 2, 1913 Kismayu, coast of Italian Somaliland.

Female (13129): Rhino Camp, West Nile Province, Uganda (Zimmer, 1927).

Owing to their rarity in eastern and central Africa, the file snakes, formerly referred to *Simocephalus* Günther (which is preoccupied by *Simocephalus* of Schödl), have reached museums only as single specimens. This has had the unfortunate result of over-description as herpetologists had insufficient material to guide them as to what characters are constant and what are variable. Matters have been further complicated by the truncated tails of the majority of such specimens as are known.

My suspicions as to the validity of the numerous species described from this region were first aroused in 1919 when Dr. G. A. Boulenger advised that a specimen from Fort Hall, which is the type locality of *unicolor*, should be referred to *butleri* despite the fact that it had only two instead of three postoculars. In 1915 Boulenger had referred *somaliensis* to the synonymy of *butleri*.

Perhaps the character most stressed by each author was that of the number of pre- and postoculars. Elsewhere it has been shown (Barbour and Loveridge, 1928, Mem. Mus. Comp. Zool., **50**, p. 114) that in the case of the allied *M. capensis* of which I obtained a series in the Usambara Mountains, either 1 or 2 preoculars and 1 or 2 postoculars are found in specimens from Amani. Obviously this character is not of specific importance in this genus.

The loreal, which was as long as deep in *chanleri*, was deeper than long in *butleri*, divided in *unicolor*, slightly longer than deep in *somaliensis* and *fiechteri*.[1] The importance of these variations is annulled by the data of the second Fort Hall specimen and the Rhino Camp snake which agrees most closely with *chanleri* in the scalation of its head, except that the latter possesses an extra postocular formed by the splitting off of the upper posterior corner of the fourth labial.

Through the courtesy of Mr. H. W. Parker, I have been able to examine the types of both *butleri* and *unicolor* and find that the ventral counts of the latter are 234 instead of 228 as stated in the original description. The British Museum has also a snake from Somaliland which agrees with *fiechteri* in lacking a postocular, a form which may be regarded as a northeastern race of *chanleri*.

The essential data, however, may best be presented for comparison in tabular form. The material is listed geographically from east to west.

[1] *Mehelia* (*Simocephalus*) *fiechteri* Scortecci, Atti. Soc. ital. Milano, **68**, p. 269, figs., 1930 (1929)—Abruzzi, Italian Somaliland.

Specimen	Midbody scale-rows	Ventrals	Caudals	Upper labials	Loreal	Preocular	Postocular	Infralabials in contact with anterior chin shields	Type locality
fiechteri, type	15	221	57	7	1	1	0	5	Abruzzi, Ital. Som.
British Museum	15	225	51	7	1	1	0	5	Somaliland
somaliensis, type	15	221	62	7	1	1	2	5	Kismayu, Ital. Som.
chanleri, type	15	?	?	7	1	1	2	5	Wange, Kenya
unicolor, type	15	234*	?	7	2	2	3	5	Fort Hall, Kenya
Nairobi Museum	15	231	?	7	1	1	2	5	Fort Hall, Kenya
Field Museum	15	238	?	7	1	1	2	5	Rhino Camp, Uganda
butleri, type	15	232	58	7	1	1	3	5	Wau to Chak Chak, Sudan

* Not 228 as in description.

There remains the coloration, which is best given in the words of the authors of each species.

M. fiechteri: "Uniformly brown above, lips and chin grayish yellow. Also grayish yellow below. Transversely along the anterior border of each ventral scale is a grayish maroon stripe which is uninterrupted in most cases, occasionally interrupted in the median line especially on the posterior two-thirds of the body." (Translation.)

M. somaliensis: "Uniformly dark slate brown above, paler greyish brown below with light edges to the gastrosteges, throat whitish."

M. chanleri: "Color above, including the lateral portion of the gastrosteges, uniform olive gray; below yellowish."

M. unicolor: "Uniform dark brown above and beneath."

M. butleri: "Black above, each scale with a whitish basal spot; white beneath, ventrals edged with black on the side; lower surface of tail greyish." The type of *butleri* is a very young snake which accounts for its more vivid coloration; all other known examples are adult.

Nairobi Museum specimen, identified as *butleri* by Boulenger: Above slate black. Below gray black, each caudal and ventral scale with light edges, lateral keels of ventrals grayish white.

Field Museum specimen: Head scalation agreeing closely with that of *chanleri*. Above, head and neck black, dorsally also, but each scale with a whitish *apical* spot. Below white, ventrals edged with gray black on the sides; lower surface of tail grayish, each scale bordered with white.

These snakes are apparently ophiophagous. The following unpublished note refers to the specimen from Fort Hall mentioned above. This big snake was encountered by a native as it was in the act of swallowing a night adder (*Causus rhombeatus*). The native

struck at the file snake and ruptured its gullet so that the head and forepart of the night adder protruded. Nine inches had already been swallowed, the total length of the prey being twenty-one inches. The specimen was taken to Dr. Nunan who later (1919) presented it to the Nairobi Museum where it now is.

Pseudaspis cana (Linnaeus).

Coluber canus Linnaeus, Syst. Nat., 1, p. 221, 1758 Indiis.

Pseudaspis cana Boulenger, Cat. Snakes Brit. Mus., 1, p. 373, 1893.

1 (16044): Kleinzee, Cape Province (Wecke, 1931).

Midbody scale-rows 27; ventrals 187; anal divided; subcaudals 70; labials 7, fourth entering the orbit. Total length 1,460 (1,180 +280) mm. Uniformly blackish.

Coluber rhodorachis (Jan).

Zamenis rhodorachis Jan, in De Filippi, Viagg. in Pers., p. 356, 1865.

Zamenis rhodorhachis (sic) Boulenger, Cat. Snakes Brit. Mus., 1, p. 398, 1893.

Zamenis rhodòrhachus (sic) Meek, Field Mus., Zool. Ser., 1, p. 179, 1897.

1 (374): South of Toyo Plain, British Somaliland (Akeley, 1896).

Midbody scale-rows 19; ventrals 212; anal divided; subcaudals 131; labials 9, fifth and sixth entering the orbit. Total length 425 (300+125) mm.

Coluber florulentulus Geoffroy.

Coluber florulentulus Geoffroy, Descr. de l'Egypte, Rept., pp. 146, 151, pl. viii, fig. 2, 1829 Egypt.

Zamenis florulentulus Boulenger, Cat. Snakes Brit. Mus., 1, p. 402, 1893.

1 (12707): West side Lake Tana, Ethiopia (Osgood, 1926).

Midbody scale-rows 21; ventrals 198; anal divided; subcaudals 94; labials 9, fifth and sixth entering the orbit. Total length 286 (219+67) mm.

Coluber hippocrepis Linnaeus.

Coluber hippocrepis Linnaeus, Syst. Nat., 1, p. 226, 1758 "America."

Zamenis hippocrepis Boulenger, Cat. Snakes Brit. Mus., 1, p. 409, 1893.

1 (4042): Atlas Mountains, Morocco (Riggenbach).

Midbody scale-rows 27; ventrals 228; anal divided; subcaudals 96; labials 9 10 excluded from the orbit; the upper portion of the rostral is split off to form a small triangular scale between the prefrontals. Total length 426 (340+86) mm.

Aeluroglena cucullata Boulenger.

Aeluroglena cucullata Boulenger, Ann. Mag. Nat. Hist., (7), **2**, p. 132, 1898 — Golis Mountains, British Somaliland.

1 (12536): Sheik Hussein, Ethiopia (Osgood, 1926).

Midbody scale-rows 21; ventrals 201; anal divided; subcaudals 80; labials 8, fourth and fifth entering the orbit. Total length 362 (276+86) mm.

This, apparently the third known specimen, not only extends the geographical range but our knowledge of variation, for the type was a female with 216 ventrals and only 67 subcaudals.

Chlorophis carinatus Andersson.

Chlorophis carinatus Andersson, Bihang Svenska Vetensk.-Akad. Handl., **27**, part 4, No. 5, p. 9, 1901 — Cameroon; Schmidt, Bull. Amer. Mus. Nat. Hist., **49**, p. 74, 1923.

1 (12746): Walikale, Belgian Congo (Heller, 1924).

Midbody scale-rows 13; ventrals 148; anal entire; subcaudals 89; labials 9, fourth, fifth, and sixth entering the orbit; postoculars 2 on the right, 3 on the left; temporals 2+2. Total length 575 (402+173) mm.

I regard *carinatus* as the western rain-forest representative of the eastern *macrops*, these two species being separated from all other members of the genus by a lower number of midbody scale-rows. From *heterodermus*, this is apparently the only distinguishing character, for though *carinatus* was said to have 40 maxillary teeth and *heterodermus* less than 25, an examination of the three snakes with 13 scale-rows available for study, reveals the fact that none has more than 16 maxillary teeth on a side. In this respect they agree with seven *heterodermus* which have from 12 to 16 teeth on each side. One wonders if Andersson, when stating that there were 40 maxillary teeth, referred to the whole series, while Boulenger undoubtedly referred to those of one side.

Although I believe the two snakes to be distinct species, it is interesting to note the numerous records of *carinatus* occurring in the same localities together with *heterodermus*. Sternfeld (1909) records both species from Johann Albrechtshöhe, Barombi and Ebolowa in Cameroon. Müller (1910) records both from Mukonje farm near Mundame, Cameroon. The Museum of Comparative Zoology has both from Metet, Cameroon.

On the other hand, although *carinatus* has an extensive range in the Belgian and Portuguese Congo, as well as in Cameroon,

reaching eastward to Uganda and western Kenya (Loveridge, MSS.), it has not yet been recorded from west of the Cameroon though *heterodermus* is known from as far west as Sierra Leone. Schmidt (loc. cit. supra) records twenty-one examples of *carinatus* from seven different localities in the Ituri Forest without any *heterodermus* being found in these places. The range of the latter does not extend into Uganda and Kenya.

Chlorophis heterodermus Hallowell.

Chlorophis heterodermus Hallowell, Proc. Acad. Nat. Sci. Phila., p. 54, 1857 Gaboon; Boulenger, Cat. Snakes Brit. Mus., 2, p. 97, 1894.

Chlorophis heterodermus pobeguini Chabanaud, Bull. Mus. Paris, **22**, p. 371, fig. 12, 1917 French Guinea.

Chlorophis cyaneus Hecht, Zool. Anz. Leipzig, **81**, p. 334, 1929 Ajoshöhe, Nyong River, Cameroon.

2 (4005 6): Efulen, Cameroon (Bates).

Midbody scale-rows 15; ventrals 150–158; anal entire; subcaudals 79 and ?; labials 9, fourth, fifth, and sixth entering the orbit; temporals 2+2; postoculars 2. Larger specimen measures 581 (428+153) mm.

1 (6975): Lake Kivu, Belgian Congo (Heller, 1924).

Midbody scale-rows 15; ventrals 174; anal entire; subcaudals 99; labials 9, fourth, fifth, and sixth entering the orbit; temporals 2+2; postoculars 2; preocular broadly separated from the frontal. Total length 725 (515+210) mm.

I was at first inclined to refer this Kivu specimen to *heterolepidotus* (Günther) despite its entire anal and low ventral count, for Sternfeld has recorded an entirely typical *heterolepidotus* from Lake Kivu. However, after prolonged consideration, it appears to me that more weight should be attached to the entire anal as a distinguishing character.

Some might wish to refer it to *C. bequaerti* Schmidt (1923, Bull. Amer. Mus. Nat. Hist., **49**, p. 75) based on two snakes with an entire anal, single anterior temporal, 164–170 ventrals, and 123 subcaudals. It is interesting to note that Schmidt records three examples of *heterolepidotus* from Niangara, the type locality of *bequaerti*.

C. h. pobeguini was based on a single specimen which had 8 labials on the left side and 9 on the right, with only 2 labials entering the orbit, the fourth and fifth on the left and the fifth and sixth on the right, and a temporal arrangement of 2+1. These

are individual aberrations for out of half-a-dozen *heterodermus* from Cameroon in the Museum of Comparative Zoology two have the right side *pobeguini* arrangement of labials on one side of the head, the normal fourth, fifth, and sixth entering the orbit on the other. One of these snakes has 1+2 temporals, as has another with wholly normal labial arrangement; the remaining four have 2+2.

C. cyaneus was based on a snake which had 8 labials, fourth and fifth entering the orbit. For further discussion on the variability of the labials in this genus, see the remarks on *C. irregularis*.

Chlorophis neglectus (Peters).

Philothamnus neglectus Peters, Monatsb. Akad. Wiss. Berlin, p. 890, 1866 Prazo Boror, Mozambique.

Chlorophis neglectus Boulenger, Cat. Snakes Brit. Mus., 2, p. 94, 1894; Meek, Field Mus., Zool. Ser., 7, p. 406, 1910; Loveridge, U. S. Nat. Mus., Bull. 151, p. 22, 1929.

3 (2256-7): Kijabe, Kenya Colony (Akeley, 1905–6).

1 (2260): Kenya Province, Kenya Colony (Akeley, 1905–6).

3 (2263–5): Athi River, Kenya Colony (Akeley, 1905–6).

1 (2266): Lake Elmenteita, Kenya Colony (Akeley, 1905–6).

1 (2270): Voi, Kenya Colony (Akeley, 1905–6).

Midbody scale-rows 15; ventrals 157–171; anal divided; subcaudals 90–120; labials 8, fourth and fifth entering the orbit except on the right side of Number 2265 where there are 9 labials of which the fifth and sixth enter the orbit. Largest specimen measures 917 (648+269) mm.

With the exception of the Elmenteita snake which was omitted, the above series are the ones referred to in Meek's paper cited above. Of the 36 lots of figures given by Meek only 11 are in agreement with the counts made here, the most misleading are 13 midbody scale-rows given for an Athi River snake and 85 subcaudals for the Voi specimen, which in reality has the end of its tail missing.

Chlorophis irregularis (Leach).

Coluber irregularis Leach, in Bowdich, Miss. Ashantee, p. 494, 1819 Ashanti, Gold Coast.

Ahaetulla emini Günther, Ann. Mag. Nat. Hist. (6), 1, p. 325, 1888 Monbuttu, Belgian Congo.

Chlorophis schubotzi Sternfeld, Wiss. Ergebn. Deutsch-Zentral-Afrika-Exped., 4, p. 269, fig., 1912 Bwanja, near Bukoba, Tanganyika Territory.

Recently Flower (1933, Proc. Zool. Soc. Lond., p. 806) synonymized *emini* with *irregularis*, using these words: "The common

green snakes of the Blue and White Niles have been referred to two species *Chlorophis irregularis* and *Chlorophis emini*, but from the Sudan specimens that I have seen I am unable to distinguish these as 'species,' as the 'keels' on the ventral shields may be perceptible, just perceptible, or not perceptible."

Werner in 1908 (1907, Sitzungsber. Akad. Wiss. Wien, **116**, abt. 1, p. 49) records both species from the Bahr el Gebel. Sternfeld (1912, loc. cit. supra, pp. 268-270) records both from Kisenji. I listed both from Yala River, Kakamega (1916, Journ. E. Africa and Uganda Nat. Hist. Soc., Nairobi, pp. 40 and 45) and invited attention to the variation displayed. Shortly after that paper was published, a third collection was received from the same source, the unpublished data from which, so far as it relates to the species under discussion, is as follows:

The *irregularis* type, with ventral keels indicated:

Number of snakes	Number of supralabials	
8	9	4th, 5th and 6th entering orbit
2	9-10	4th, 5th and 6th entering orbit
1	10 10	4th, 5th and 6th entering orbit

The *emini* type, without ventral keels:

Number of snakes	Number of supralabials	
1	8-7	3rd, 4th and 5th entering orbit
1	8 7	4th, 5th, 6th and 3rd, 4th, 5th entering orbit
1	8	3rd, 4th and 5th entering orbit
2	8	4th, 5th and 6th entering orbit
2	8-9	4th, 5th and 6th entering orbit
4	9 8	4th, 5th and 6th entering orbit
1	9 8	4th, 5th and 3rd, 4th, 5th entering orbit
1	9	4th, 5th, 6th and 5th, 6th entering orbit
14	9	4th, 5th and 6th entering orbit

The position appears to be that on the extreme West Coast keels are always present on the ventrals but that in the central and eastern parts of its range *irregularis* may or may not have keels, all the way from Khartoum to Lake Nyasa. As there are no scale or color characters by which one might retain *emini* as an eastern race, I concur with Flower in regarding it as a strict synonym of *irregularis*.

Chlorophis schubotzi was proposed by Sternfeld for a snake *taken with irregularis* at Bwanja near Bukoba. In passing, I might add that *emini* has been reported from Bukoba by several authors. *C. schubotzi* was differentiated by the possession of seven supralabials of which the third, fourth, and fifth entered the orbit. As will be seen from the variation recorded above, this condition occurs on

one side of two Yala River snakes, while another has 8 labials, the third, fourth, and fifth entering the orbit. I do not think that there was any justification for naming *schubotzi* as distinct from *irregularis*. Below, however, I list the Field Museum material in three groups, first *irregularis* with keels on the ventrals, then *emini* without such lateral keels, finally three individuals which have the same labials entering the orbit as had the holotype of *schubotzi* but 8 upper labials, not 7 as was the case with *schubotzi*.

2 (12966–7): Kabengere, Belgian Congo (Zimmer, 1926).

Midbody scale-rows 15; ventrals 159–160; anal divided; subcaudals 101–104; labials 9, fourth, fifth, and sixth entering the orbit; preocular only slightly separated from the frontal, practically in contact on the left side of the head in one snake. Larger specimen measures 847 (598+249) mm.

2 (4007–8): Mount Ruwenzori, Uganda (Ruwenzori Exped., 1906).

5 (8976–7, 8979, 9909–10): Lake Bunyoni, Uganda (Heller, 1925).

1 (12729): Metemma, Ethiopia (Osgood, 1927).

3 (12874–5, 12880): Katobwe, Belgian Congo (Zimmer, 1926).

1 (12977): Kabengere, Belgian Congo (Zimmer, 1926).

Midbody scale-rows 15; ventrals 154–179; anal divided; subcaudals 91–134; labials 9, fourth, fifth, and sixth entering the orbit *except on one side* of the head in Nos. 4008, 9909, and 12880 where there are only 8 labials, of which the third, fourth, and fifth enter the orbit (see other material below). Largest specimen measures 896 (614+282) mm.

1 (8982): Bihunga Escarpment, Uganda (Heller, 1925).

1 (12870): Katobwe, Belgian Congo (Zimmer, 1926).

1 (12988): Kabengere, Belgian Congo (Zimmer, 1926).

Midbody scale-rows 15; ventrals 160–163; anal divided; subcaudals 109 in all three snakes; labials 8, third, fourth, and fifth entering the orbit. Largest specimen measures 890 (610+280) mm.

Philothamnus semivariegatus semivariegatus (Smith).

Dendrophis (Philothamnus) semivariegatus Smith, Illus. Zool. S. Africa, 3, pls. lix, lx, and lxiv, fig. 1, 1840—Bushman Flat and country beyond Kurrichane, Cape Colony.

Philothamnus semivariegatus Boulenger, Cat. Snakes Brit. Mus., 2, p. 99, 1894.

Philothammus semivariegatus (sic) Meek, Field Mus., Zool. Ser., 1, p. 179, 1897.

1 (373): Sheik, Golis Mountains, British Somaliland (Akeley, 1896).

1 (12329): Ulambo, Tanganyika Territory (Zimmer, 1926).

3 (12974, 12976, 12986): Kabengere, Belgian Congo (Zimmer, 1926).

Midbody scale-rows 15; ventrals 171–189; anal divided; subcaudals 119–136; labials 9, fourth, fifth, and sixth entering the orbit; temporals 2+2 on seven sides, 1+2 on three sides. Largest specimen measures 989 (652+337) mm.

Gastropyxis smaragdina (Schlegel).

Dendrophis smaragdina Schlegel, Essai Phys. Serp., 2, p. 237, 1837—Gold Coast.

Gastropyxis smaragdina Boulenger, Cat. Snakes Brit. Mus., 2, p. 103, 1894.

2 (4022–3): Ja River, Cameroon (Bates).

Midbody scale-rows 15; ventrals 154–155; anal divided; subcaudals 150–151; labials 9, fifth and sixth entering the orbit (damaged in No. 4023); temporals 1+2. Larger specimen measures 990 (602+388) mm.

Hapsidophrys lineata Fischer.

Hapsidophrys lineatus Fischer, Abh. Natur. Ver. Hamburg, 3, p. 111, pl. ii, fig. 5, 1856—Elmine, West Africa (i.e. Elmina, Gold Coast).

Hapsidophrys lineata Boulenger, Cat. Snakes Brit. Mus., 2, p. 104, 1894.

1 (4021): Bitye, Cameroon (Bates).

Midbody scale-rows 15, ventrals 160; anal entire; subcaudals?; labials 8, fourth and fifth entering the orbit on the right side; on the left side, however, there are only 6 labials owing to a fusion of the sixth, seventh, and eighth; temporals 2+2. Head and body measure 680 mm., tail mutilated.

Coronella semiornata semiornata Peters.

Coronella semiornata Peters, Monatsb. Akad. Wiss. Berlin, p. 622, 1854—Tete, Mozambique; Boulenger, Cat. Snakes Brit. Mus., 2, p. 195, 1894; Meek, Field Mus. Nat. Hist., Zool. Ser., 7, p. 405, 1910.

1 (2254): Voi, Kenya Colony (Akeley, 1905–7).

1 (2394): Kijabe, Kenya Colony (Akeley, 1905–7).

Midbody scale-rows 21; ventrals 182–190; anal divided; subcaudals 84–92; labials 8, fourth and fifth entering the orbit. Larger specimen measures 542 (415+127) mm.

Grayia tholloni Mocquard.

Grayia tholloni Mocquard, Bull. Soc. Philom. Paris, (8), 9, p. 11, 1897—French Congo; Boulenger, Proc. Zool. Soc. Lond., p. 951, fig., 1909.

1 (12877): Katobwe, Belgian Congo (Zimmer, 1926).

Midbody scale-rows 15; ventrals 137; anal divided; subcaudals?; labials 8, fourth entering the orbit. Head and body measure 402 mm.; tail mutilated.

Grayia ornata (Bocage).

Macrophis ornatus Bocage, Jorn. Sci. Lisboa, 1, p. 67, 1866—Duque de Bragança, Angola.

Grayia ornata Boulenger, Proc. Zool. Soc. Lond., p. 944, fig., 1909.

1 (12978): Kabengere, Belgian Congo (Zimmer, 1926).

Midbody scale-rows 17; ventrals 144; anal divided; subcaudals 67; labials 8, fourth entering the orbit. Total length 1,215 (905+310) mm.

Duberria lutrix shiranum (Boulenger).

Homalosoma shiranum Boulenger, Cat. Snakes Brit. Mus., 2, p. 276, pl. xiii, fig. 1, 1894—Shiré Highlands, Nyasaland.

Duberria lutrix shiranum Loveridge, Bull. Mus. Comp. Zool., 74, p. 241, 1933.

1 (9884): Kisolo, Uganda (Heller, 1926).

4 (9911, 9915, 9918–9): Lake Bunyoni, Uganda (Heller, 1926).

Midbody scale-rows 15; ventrals 120–138; anal entire; subcaudals 23–31; labials 6, third and fourth entering the orbit except on right side of No. 9884 where there are only five labials; postocular 1; loreal absent in 1½ instances, present in 3½. Largest specimen measures 434 (384+50) mm. These snakes come from the area of intermediates referred to in the 1932 citation above and though they are predominatingly *lutrix* in some respects they scarcely affect the averages.

COLUBRIDAE (DASYPELTINAE)

Dasypeltis scaber (Linnaeus).

Coluber scaber Linnaeus, Syst. Nat., 1, p. 223, 1758—Indiis.

Dasypeltis scabra Boulenger, Cat. Snakes Brit. Mus., 2, p. 354, 1894.

2 (4011–2): Harar, Ethiopia (Kristensen).

3 (9912–4): Lake Bunyoni, Uganda (Heller, 1926).

1 (12728): Gondar, Ethiopia (Bailey, 1927).

1 (12823): Mambawanga Hill, Belgian Congo (Heller, 1925).

2 (12836, 12841): Ruchuru, Belgian Congo (Heller, 1925).

Midbody scale-rows 23–25; ventrals 212–234; anal entire; subcaudals 51–67; labials 6–7, third and fourth entering the orbit, or 8, third, fourth, and fifth in No. 12841 and on right side of No. 9913. Largest specimen measures 728 (628+100) mm.

COLUBRIDAE (BOIGINAE)

Boiga pulverulenta (Fischer).

Dipsas pulverulenta Fischer, Abh. Naturw. Ver. Hamburg, 3, p. 81, pl. iii, fig. 1, 1856—Edina, Grand Bassa County, Liberia.

Dipsadomorphus pulverulentus Boulenger, Cat. Snakes Brit. Mus., 3, p. 68, 1896.

2 (4017–8): Ja River, Cameroon (Bates).

Midbody scale-rows 19; ventrals 248–250; anal entire; subcaudals 106–110; labials 8, third, fourth, and fifth entering the orbit. Larger snake measures 1,001 (797+204) mm.

Dipsadoboa unicolor Günther.

Dipsadoboa unicolor Günther, Cat. Snakes Brit. Mus., p. 183, 1858—West Africa; Boulenger, Cat. Snakes Brit. Mus., 3, p. 81, 1896.

1 (4013): Efulen, Cameroon (Bates).

1 (4014): Ja River, Cameroon (Bates).

Midbody scale-rows 17; ventrals 192–194; anal entire; subcaudals entire 83 and ?; labials 8, third, fourth, and fifth, or fourth and fifth entering the orbit. Larger specimen measures 541 (424+117) mm.

Crotaphopeltis hotamboeia hotamboeia (Laurenti).

Coronella hotamboeia Laurenti, Syn. Rept., p. 85, 1768—India orientali, i.e. Africa.

Leptodira hotamboeia Boulenger, Cat. Snakes Brit. Mus., 3, p. 89, 1896; Meek, Field Mus. Nat. Hist., Zool. Ser., 7, p. 406, 1910.

Crotaphopeltis hotamboeia hotamboeia Barbour and Loveridge, Mem. Mus. Comp. Zool., 50, p. 125, 1928.

1 (2259): Mount Kenya, Kenya Colony (Akeley, 1906).

1 (2264): Athi River, Kenya Colony (Akeley, 1906).

1 (2267): Lake Elmenteita, Kenya Colony (Akeley, 1906).

1 (4036): Irumu, Belgian Congo (Ruwenzori Expedition, 1906).

2 (4037–8): Harar, Ethiopia (Kristensen).

2 (12878, 12896): Katobwe, Belgian Congo (Zimmer, 1926).

Midbody scale-rows 19–21; ventrals 161–178; anal entire; subcaudals 36–47; labials 8–9, third, fourth, and fifth, or fourth and fifth, or fourth, fifth, and sixth entering the orbit; preocular 1, not in contact with the frontal; temporals 1+2; on right side of No. 4037, 1+1+2. Largest specimen measures 613 (528+85) mm.

Amplorhinus nototaenia (Günther).

Coronella nototaenia Günther, Proc. Zool. Soc. Lond., p. 309, pl. xxvi, fig. 1, 1864—Rios de Sena, Zambesi.

Amplorhinus nototaenia Boulenger, Cat. Snakes Brit. Mus., 3, p. 125, 1896.

1 (12251): Lake Manka, Tanganyika Territory (Zimmer, 1927).

Midbody scale-rows 17; ventrals 177; anal divided; subcaudals 87; labials 8, fourth and fifth entering the orbit; temporals 2+3. Length of head and body 312 mm., tail mutilated.

Malpolon monspessulanus monspessulanus (Hermann).

Coluber monspessulanus Hermann, Obs. Zool., 1, p. 283, 1804—Monspelio, i.e. Montpellier, France.

Coelopeltis monspessulanus Boulenger, Cat. Snakes Brit. Mus., 3, p. 141, 1896.

1 (11995): Atlas Mountains, Morocco (Riggenbach).

Midbody scale-rows 19; ventrals 176; anal divided; subcaudals 87+; labials 8, fourth and fifth entering the orbit; loreals 2; frontal very narrow. Length of head and body 855 mm., tail tip missing.

Trimerorhinus tritaeniatus multisquamis Loveridge.

Trimerorhinus tritaeniatus Meek, Field Mus. Nat. Hist., Zool. Ser., 7, p. 405, 1910.

Trimerorhinus tritaeniatus multisquamis Loveridge, Proc. Biol. Soc. Wash., 45, p. 84, 1932—Nairobi, Kenya Colony.

1 (2258): Naivasha, Kenya Colony (Akeley, 1906).

1 (2262): Athi River, Kenya Colony (Akeley, 1906).

1 (2271): Voi, Kenya Colony (Akeley, 1906).

2 (2393): Molo, Kenya Colony (Akeley, 1906).

1 (12513): Allata, Ethiopia (Osgood, 1927).

1 (12525): Webi Shebeli, Ethiopia (Osgood, 1927).

All the above series are paratypes.

Midbody scale-rows 17; ventrals 167–183; anal divided; subcaudals 54–63; labials 8, fourth and fifth entering the orbit except in the Voi snake where there are 9 with fifth and sixth entering, and the right side of a Molo snake where there are 9 with fourth, fifth, and sixth entering the orbit. The Allata snake is the largest example of this race which I have ever seen, surpassing by over 150 mm. the biggest in a series of thirty-five of the typical race which I

collected in 1930; it measures 1,159+ (995+164+tip of tail which is missing) mm.

The data on which I based this race was as follows:

T. t. tritaeniatus Günther.

	Ventrals	Caudals
13 (type and specimens *b* to *m* of Boulenger)	149–163	53–65
5 (types of *variabilis* and Zomba specimen)	155–159	52–60
(The ventral count given by Boulenger is incorrect)		
35 (collected in southern Tanganyika, 1930)	145–162	51–60
2 (from northern Rhodesia and Transvaal, in M.C.Z.)	150 162	62
Range	145 163	51–65

Subsequently Mr. H. W. Parker kindly sent me the ventral counts of ten other snakes from Nyasaland, as well as northern and southern Rhodesia; these ranged from 153 to 161.

Three other specimens from Mossamedes, and Lofoi, Katanga, respectively, have 162, 167, and 170 ventrals which would place them in the *multisquamis* group so well defined east of the Great Lakes.

Nine others from Kenya Colony and Ethiopia bear out my conclusions by having a ventral count ranging from 163 to 181.

T. t. multisquamis Loveridge.

	Ventrals	Caudals
3 (specimens *n*, *o*, and *p* of Boulenger)	165–170	63–66
8 (from Kenya Colony in Nairobi Museum)	170–181	57–56
2 (from Kenya Colony in Mus. Comp. Zool.)	167–178	57–59
1 (from Arusha, Tanganyika, in Mus. Comp. Zool.)	174	61
22 (from Kenya Colony in U. S. National Museum)	163 178	54 63
7 (from Kenya and Ethiopia in Field Museum)	162–183	54–63
Range	162–183	54–66

Rhamphiophis rostratus Peters.

Rhamphiophis rostratus Peters, Monatsb. Akad. Wiss. Berlin, p. 624, 1854 - Tete; Mesuril; and Quitangonha, Mozambique.

Rhamphiophis oxyrhynchus Boulenger (part, not of Reinhardt), Cat. Snakes Brit. Mus., 3, p. 146, 1896; Meek, Field Mus. Nat. Hist., Zool. Ser., 7, p. 405, 1910.

1 (16143): Voi, Kenya Colony (Akeley, 1906).

Midbody scale-rows 17; ventrals 171; anal divided; subcaudals 115; labials 8, fourth and fifth entering the orbit; preoculars not in contact with the frontal; posterior chin-shields longer than the anterior. Total length 897 (611+286) mm.

The name *oxyrhynchus* Reinhardt is now restricted to the West African species.

Dromophis lineatus (Duméril and Bibron).

Dryophylax lineatus Duméril and Bibron, Erpét. Gén., 7, p. 1124, 1854—White Nile, Africa.

Dromophis lineatus Boulenger, Cat. Snakes Brit. Mus., 3, p. 149, 1896.

1 (12876): Katobwe, Belgian Congo (Zimmer, 1926).

Midbody scale-rows 17; ventrals 149; anal divided; subcaudals ?; labials 8, fourth and fifth entering the orbit; preocular 1; postocular 2; temporals 1+1+2 (right), 1+1+3 (left). Length of head and body 680 mm., tail mutilated.

Psammophis subtaeniatus Peters.

Psammophis sibilans var. *subtaeniata* Peters, Reise nach Mossamb., 3, p. 121, 1882—Boror and inland from Tete, Mozambique.

Psammophis subtaeniatus Boulenger, Cat. Snakes Brit. Mus., 3, p. 160, 1896.

Psammophis sibilans Meek (not of Linnaeus), Field Mus. Nat. Hist., Zool. Ser., 7, p. 405, 1910.

1 (2250): Voi, Kenya Colony (Akeley, 1906).

Midbody scale-rows 17; ventrals 157; anal divided; subcaudals ?; labials 8, fourth and fifth entering the orbit; preocular 1; postoculars 2; temporals 2+2. Length of head and body 542 mm., tail mutilated.

Psammophis sibilans (Linnaeus).

Coluber sibilans Linnaeus (part), Syst. Nat., 1, p. 222, 1758—"Asia."

Psammophis sibilans Boulenger, Cat. Snakes Brit. Mus., 3, p. 161.

1 (12976): Kabengere, Belgian Congo (Zimmer, 1926).

1 (12990): Bukama, Belgian Congo (Zimmer, 1926).

7 (15354–60): Cuma, Angola (Hambly, 1929).

Midbody scale-rows 17; ventrals 168–178; anal divided; subcaudals 89–91 but in seven other specimens the tail is mutilated; labials 8, fourth and fifth entering the orbit. Longest perfect specimen measures 1,114 (809+305) mm.

Psammophis furcatus Peters.

Psammophis furcatus Peters, Monatsb. Akad. Wiss. Berlin, p. 236, 1867—Otjimbingue, Southwest Protectorate; Boulenger, Cat. Snakes Brit. Mus., 3, p. 164, 1896.

Psammophis leightoni Boulenger, Proc. Zool. Soc. Lond., p. 126, pl. xii, 1902—Erste River Station, near Cape Town, Cape Colony.

3 (16041–3): Kleinzee, Cape Province (Wecke, 1931).

Midbody scale-rows 17; ventrals 168–169; anal divided; subcaudals 88–109; labials 8, fourth and fifth entering the orbit; pre-

ocular 1, in contact with the frontal. Largest specimen measures 833 (567+266) mm.

Psammophis biseriatus Peters.

Psammophis biseriatus Peters, Sitzber. Ges. naturf. Freunde Berlin, p. 88, 1881—Taita, Kenya Colony; Boulenger, Cat. Snakes Brit. Mus., **3**, p. 168, 1896.

Psammophis sibilans Meek (not of Linnaeus), Field Mus., Zool. Ser., **1**, p. 179, 1897.

1 (372): Sheik, Golis Mountains, British Somaliland (Akeley, 1896).

2 (12243, 12250): Lake Manka, Tanganyika Territory (Zimmer, 1926).

Midbody scale-rows 15; ventrals 144–148; anal divided; subcaudals 98–117; labials 9, fourth, fifth, and sixth, or fifth and sixth entering the orbit; temporals 2+3 and 2+2. Largest specimen measures 669 (442+227) mm.

Psammophis crucifer (Daudin).

Coluber crucifer Daudin, Hist. Rept., **7**, p. 189, 1803—"Indes orientales."

Psammophis crucifer Boulenger, Cat. Snakes Brit. Mus., **3**, p. 169, 1896.

1 (15549): Lady Frere, Cape Province (Romer, 1931).

1 (16035): Kleinzee, Cape Province (Wecke, 1931).

Midbody scale-rows 15; ventrals 140–156; anal divided; subcaudals 66–73; labials 7–8, third and fourth, or fourth and fifth entering the orbit; preocular not in contact with the frontal. Larger specimen measures 475 (360+115) mm.

Macroprotodon cucullatus (Geoffroy).

Coluber cucullatus Geoffroy, Descr. de l'Egypte, Rept., pp. 148 and 151, pl. viii, fig. 3, 1827—Atlas Mountains.

Macroprotodon cucullatus Boulenger, Cat. Snakes Brit. Mus., **3**, p. 175, 1896.

2 (4043–4): Atlas Mountains, Morocco (Riggenbach).

Midbody scale-rows 23; ventrals 163–178; anal divided; subcaudals 43–46; labials 8, fourth and fifth entering the orbit. Larger specimen measures 335 (286+49) mm.

Thelotornis kirtlandii (Hallowell).

Leptophis kirtlandii Hallowell, Proc. Acad. Nat. Sci. Phila., p. 62, 1844—Liberia.

Thelotornis kirtlandii Boulenger, Cat. Snakes Brit. Mus., **3**, p. 185, 1896.

1 (4019): Benito River, Spanish Guinea (Bates).

1 (4020): Ja River, Cameroon (Bates).

1 (12288): Uleia, Tanganyika Territory (Zimmer, 1926).

1 (15462): Caconda, Angola (Hambly, 1909).

Midbody scale-rows 19; ventrals 156–176; anal divided; subcaudals 141–166; labials 8–9, fourth and fifth entering the orbit. Largest specimen measures 1,470 (935+535) mm.

Dispholidus typus (Smith).

Bucephalus typus Smith, Zool. Journ., 4, p. 441, 1829—Old Latakoo, South Africa.

Dispholidus typus Boulenger, Cat. Snakes Brit. Mus., 3, p. 187, 1896.

2 (15465–6): Caconda, Angola (Hambly, 1909).

Midbody scale-rows 19; ventrals 181–191; anal divided; subcaudals 101–104; labials 7, third and fourth entering the orbit. Larger specimen measures 1,172 (885+287) mm.

Miodon gabonensis (Duméril).

Elapomorphus gabonensis Duméril, Rev. Mag. Zool., (2), 7, p. 468, 1856—Gaboon, West Africa.

Miodon gabonensis Boulenger, Cat. Snakes Brit. Mus., 3, p. 252, 1896.

1 (12825): Mambawanga Hill, Belgian Congo (Heller, 1925).

Midbody scale-rows 15; ventrals 217; anal divided; subcaudals 24; labials 7, third and fourth entering the orbit; fifth labial forming a slight suture with the parietal as in *Calamelaps;* nasal completely divided; internasal equal to, or a trifle longer than, the prefrontals. Total length 661 (617+44) mm.

This male is uniformly black above and below, an almost exact counterpart of a female which I took at Ilolo, Rungwę district, near Lake Nyasa in 1930; the latter has two more ventrals and three more subcaudals.

Elapops modestus Günther.

Elapops modestus Günther, Ann. Mag. Nat. Hist., (3), 4, p. 161, pl. iv, fig. C, 1859—West Africa; Boulenger, Cat. Snakes Brit. Mus., 3, p. 262, 1896.

1 (4024): Ja River, Cameroon (Bates).

1 (4025): Bitye, Cameroon (Bates).

Midbody scale-rows 15; ventrals 145–150; anal entire; subcaudals 38–45; labials 7, third and fourth entering the orbit. Larger specimen measures 409 (335+74) mm.

COLUBRIDAE (ELAPINAE)

Elapsoidea güntherii Bocage.

Elapsoidea güntherii Bocage, Jorn. Sci. Lisboa, **1**, p. 70, pl. i, fig. 3, 1866 Cabinda, Angola and Bissao, Portuguese Guinea.

Elapechis guentheri Boulenger, Cat. Snakes Brit. Mus., **3**, p. 349, 1896; Meek, Field Mus. Nat. Hist., Zool. Ser., **7**, p. 405, 1910.

1 (2255): Kijabe, Kenya Colony (Akeley, 1905–7).

1 (15467): Caconda, Angola (Hambly, 1909).

Midbody scale-rows 13; ventrals 138–158; anal entire; subcaudals 13 24; labials 7, third and fourth entering the orbit. Larger specimen measures 217 (195+22) mm.

Undoubtedly east and central African specimens average a higher ventral count than some Angolan snakes. In fifty east and central African records the ventrals range from 153 to 163. Two Angolan snakes available are 138 and 143 but the types of *güntherii* had 153 and 155, while its synonym *semiannulata* Bocage had 143 and a second specimen recorded later by Bocage had 145. Whether a central and east African race, for which the name *nigra* Günther (Zanzibar) would be available, can be established depends on the accumulation of further data from Angolan material.

Naja melanoleuca Hallowell.

Naia haie var. *melanoleuca* Hallowell, Proc. Acad. Nat. Sci. Phila., p. 61, 1857 Gaboon, West Africa.

Naia melanoleuca Boulenger, Cat. Snakes Brit. Mus., **3**, p. 376, 1896.

1 (12838): Ruchuru, Belgian Congo (Heller, 1925).

Midbody scale-rows 19; ventrals 206; anal entire; subcaudals 59; labials 7, third and fourth entering the orbit. Total length 504 (425+79) mm.

Naja nigricollis nigricollis Reinhardt.

Naja nigricollis Reinhardt, Dansk. Vidensk. Selsk. Skrift., **10**, p. 269, pl. iii, figs. 5 and 7, 1843—Guinea, West Africa.

Naia nigricollis Boulenger, Cat. Snakes Brit. Mus., **3**, p. 378, 1896; Meek, Field Mus., Zool. Ser., **1**, p. 179, 1897.

1 (12306): Uleia, Tanganyika Territory (Zimmer, 1927).

1 (12873): Katobwe, Belgian Congo (Zimmer, 1926).

1 (12906): Kabengere, Belgian Congo (Zimmer, 1926).

Midbody scale-rows 19–21; ventrals 177–181; anal entire; subcaudals 54–62; labials 6, third entering the orbit. Largest specimen measures 1,395 (1,138+257) mm.

Naja goldii Boulenger.

Naia goldii Boulenger, Ann. Mag. Nat. Hist., (6), **16**, p. 34, 1895 Asaba, Nigeria; Cat. Snakes Brit. Mus., 3, p. 387, pl. xx, fig. 2, 1896.

1 (6977): Irumu, Belgian Congo (Heller, 1924).

Midbody scale-rows 15; ventrals 192; anal entire; subcaudals?; labials 7, third and fourth entering the orbit. Head and body measure 2,130 mm., tail mutilated.

Elaps lacteus (Linnaeus).

Coluber lacteus Linnaeus, Syst. Nat., **1**, p. 220, 1758 "Indiis."

Homorelaps lacteus Boulenger, Cat. Snakes Brit. Mus., 3, p. 409, 1896.

1 (16037): Kleinzee, Cape Province (Wecke, 1931).

Midbody scale-rows 15; ventrals 220; anal divided; subcaudals 36; labials 6, third and fourth entering the orbit. Total length 328 (294+34) mm.

Despite the high number of ventral scutes (*lacteus* 160 215) this snake is undoubtedly *lacteus* and not *dorsalis* (219 244).

Dendraspis jamesoni kaimosae Loveridge.

Dendraspis jamesoni kaimosae Loveridge, Proc. Biol. Soc. Wash., **49**, p. 64, 1936 Kaimosi, Kakamega District, Kenya Colony.

1 (12822): Mambawanga Hill, Belgian Congo (Heller, 1925).

2 (12839–40): Ruchuru, Belgian Congo (Heller, 1925).

Midbody scale-rows 15; ventrals 215–217; anal divided; subcaudals 95–109; labials 7–8, the third and fourth, or fourth only, or fifth only, entering the orbit. Largest specimen measures 1,892 (1,400+492) mm. but is a skin with head and tail attached.

No. 12840 is an intermediate between the eastern and western races of *jamesoni* of which the other two specimens are paratypes.

Dendraspis angusticeps (Smith).

Naja angusticeps Smith, Illus. Zool. S. Africa, 3, pl. lxx, 1849 Natal and the country eastward towards Delagoa Bay.

Dendraspis angusticeps Boulenger, Cat. Snakes Brit. Mus., 3, p. 437, 1896; Loveridge, Bull. Mus. Comp. Zool., **74**, p. 273, 1933.

1 (12738): Near Lake Tana, Ethiopia (Fuertes, 1927).

Midbody scale-rows 23; ventrals 254; anal divided; subcaudals 113; labials 8, fourth below the eye; the large lower temporal reaches the lip on the left side but on the right is separated by horizontal division which forms a labial; the posterior upper temporal is vertically divided so that there are three temporals along the outer border

of the parietal on either side. Total length of skin with head and tail attached 2,420 (1,900+520) mm.

No importance need be attached to these variations as mambas are particularly liable to individual aberrations as can be seen when large series are obtained from one locality. It appears probable that *antinorii* which was described from Anseba, Ethiopia, should be, like *sjoestedti* Lönnberg and *transvallensis* Gough, relegated to the synonymy of *angusticeps* Smith.

Dr. W. H. Osgood has kindly furnished me with the following quotation from the diary of the late Mr. L. A. Fuertes as it relates to the collecting of the specimen listed above: "A little later on, our guide, just ahead of me, stopped short and sucked in his breath, and pointed, bung-eyed, at the trail-side, and there, gliding slowly and silently along, was the first big snake of our trip, a gray-green smooth-scaled one some seven feet long and 1½ inches to 1¾ inches in diameter. I auxed[1] it in the neck, stopping but not killing it. We accomplished that, however, without mutilating it, skinned it, with head entire, for the formalin box—a good catch. It had two needle sharp teeth, one of which pricked me a little; just enough to show that you can't be too careful, if careful enough! The men were all spellbound and got a grand shudder; they are scared pink of snakes, but with better reason than at home, for here a large proportion of the species are venomous, and many very deadly."

Mr. Fuertes was under a misapprehension as to the large proportion of venomous species in Ethiopia, not more than one in six being dangerous to man; it is highly probable that the incidence of individuals of the venomous species is no higher than in other parts of Africa.

It was undoubtedly a Green Mamba to which Dr. D. G. Elliot referred in his introductory note to the "List of Fishes and Reptiles obtained by the Field Columbian Museum East African Expedition to Somaliland in 1896" (1897, Field Columbian Mus., Zool. Ser., **1**, p. 163) when he wrote:

> "snakes were only occasionally seen. Perhaps, as we did not hunt for them, may account for their apparent rarity. Many are poisonous, and I was surprised to find a green tree snake, nine feet long, that was killed by Mr. Dodson near our camp at Bohobgashan, was furnished with long fangs and was evidently a dangerous customer. The shot injured the skin so much that it was not brought back with us."

[1] Shot with auxiliary collecting gun.

VIPERIDAE

Causus rhombeatus (Lichtenstein).

Sepedon rhombeatus Lichtenstein, Verz. Doubl. Mus. Berlin, p. 106, 1823—no locality.

Causus rhombeatus Boulenger, Cat. Snakes Brit. Mus., 3, p. 467, 1896.

Causus resimus Meek (not of Peters), Field Mus. Nat. Hist., Zool. Ser., 7, p. 405, 1910.

1 (2268): Nairobi, Kenya Colony (Akeley, 1905-7).

1 (4004): Benguela, Angola (Ansorge).

5 (12902-3, 12968-9, 12991): Kabengere, Belgian Congo (Zimmer, 1926).

Midbody scale-rows 17-18; ventrals 140-155; anal entire; subcaudals 22-33; labials 6. Largest specimen measures 674 (607+67) mm. The latter is the Nairobi specimen most unfortunately referred to *resimus* by Meek who gave its tail length as 17 instead of 67 mm., its midbody scale-rows as 17 instead of 18, and its ventral count as 161 instead of 155.

Causus resimus (Peters).

Heterophis resimus Peters, Monatsb. Akad. Wiss. Berlin, p. 277, pl., fig. 4, 1862—Gebel Ghule, Senaar, Sudan.

Causus resimus Boulenger, Cat. Snakes Brit. Mus., 3, p. 468, 1896.

1 (4003): Angola (Ansorge).

Midbody scale-rows 21; ventrals 142; anal entire; subcaudals 20; labials 7. Total length 496 (450+46) mm.

Causus lichtensteinii (Jan).

Aspidelaps lichtensteinii Jan, Rev. Mag. Zool., p. 511, 1859—Gold Coast.

Causus lichtensteinii Boulenger, Cat. Snakes Brit. Mus., 3, p. 470, 1896.

1 (6974): Irumu-Beni Road, Belgian Congo (Heller, 1924).

Midbody scale-rows 15; ventrals 148; anal entire; subcaudals 17; labials 6. Total length 480 (442+38) mm.

Vipera hindii Boulenger.

Vipera hindii Boulenger, Ann. Mag. Nat. Hist., (8), 5, p. 513, 1910—Aberdare Mountains, Kenya Colony; Meek, Field Mus. Nat. Hist., Zool. Ser., 7, p. 405, 1910.

2 (2252-3): Aberdare Mountains, Kenya Colony (Akeley, 1905-7).

Midbody scale-rows 27; ventrals male 132, female 129; anal entire; caudals male 33, female 26; labials 8. Total length: 233

(202+31) mm., female 290 (258+32) mm. These are the two specimens mentioned by Meek though the measurements and scale counts given here are so totally at variance with his figures.

Bitis arietans (Merrem).

Vipera (Echidna) arietans Merrem, Tent. Syst. Amph., p. 152, 1820—Cape of Good Hope.

Bitis arietans Boulenger, Cat. Snakes Brit. Mus., 3, p. 493, 1896; Meek, Field Mus. Nat. Hist., Zool. Ser., 7, p. 405, 1910.

1 (2269): Nairobi, Kenya Colony (Akeley, 1905–7).

3 (15351-3): Cuma, Angola (Hambly, 1929).

Midbody scale-rows 29-35; ventrals 129-137; anal entire; subcaudals 14–28; labials 12-15. Largest specimen measures 839 (780+59) mm.

Bitis gabonica (Duméril and Bibron).

Echidna gabonica Duméril and Bibron, Erpét. Gén., 7, p. 1428, pl. lxxxb, 1854—Gaboon, West Africa.

Bitis gabonica Boulenger, Cat. Snakes Brit. Mus., 3, p. 499, 1896.

2 (12818-9): Mambawanga Hill, Belgian Congo (Heller, 1925).

Midbody scale-rows 39–41; ventrals 133; anal entire; subcaudals 19; labials 15. Larger specimen measures 665 (622+43) mm. but is a skin with head and tail attached.

Bitis nasicornis (Shaw).

Coluber nasicornis Shaw, Nat. Miscell., 3, pl. xciv, 1802—interior of Africa.

Bitis nasicornis Boulenger, Cat. Snakes Brit. Mus., 3, p. 500, 1896.

1 (3996): Bitye, Cameroon (Bates).

1 (12820): Mambawanga Hill, Belgian Congo (Heller, 1925).

Midbody scale-rows 35-41; ventrals 123–134; anal entire; subcaudals 20 28; labials 16 18. Larger specimen measures 967 (882+85) mm.

Bitis cornuta (Daudin).

Vipera cornuta Daudin, Hist. Rept., 6, p. 188, 1803 - Cape of Good Hope.

Bitis cornuta Boulenger, Cat. Snakes Brit. Mus., 3, p. 497, 1896.

2 (16039-40): Kleinzee, Cape Province (Wecke, 1931).

Midbody scale-rows 29; ventrals 137-143; anal single; caudals 26–34; labials 14. Larger specimen measures 374 (327+47) mm.

Bitis caudalis (Smith).

Vipera caudalis Smith, Illus. Zool. S. Africa, 3, pl. vii, 1849—sandy districts north of the Cape Colony.

Bitis caudalis Boulenger, Cat. Snakes Brit. Mus., 3, p. 498, 1896.

1 (16038): Kleinzee, Cape Province (Wecke, 1931).

Midbody scale-rows 23; ventrals 109; anal entire; subcaudals 21; labials 10. Total length 224 (200+24) mm.

Echis carinatus (Schneider).

Pseudoboa carinata Schneider, Hist. Amph., 2, p. 285, 1801—no locality.

Echis carinatus Boulenger, Cat. Snakes Brit. Mus., 3, p. 505, 1896; Meek, Field Mus., Zool. Ser., 1, p. 179, 1897.

1 (376): Hullieh, Somaliland Protectorate (Akeley, 1896).

Midbody scale-rows 28; ventrals?; anal entire; subcaudals 37; labials 10. Length?

This specimen is identified by locality rather than on taxonomic grounds for the scales on its snout are smooth while those on the vertex might well be considered as obtusely keeled; moreover, it has three series of scales between the eye and the upper labials, a condition usual in *coloratus*, rare in *carinatus*.

Atheris squamigera (Hallowell).

Echis squamigera Hallowell, Proc. Acad. Nat. Sci. Phila., p. 193, 1854—near the River Gaboon.

Atheris squamiger Boulenger, Cat. Snakes Brit. Mus., 3, p. 509, 1896.

1 (12821): Mambawanga Hill, Belgian Congo (Heller, 1925).

1 (12837): Ruchuru, Belgian Congo (Heller, 1925).

Midbody scale-rows 21; ventrals 159–162; anal entire; subcaudals 49–54; labials 10. Larger specimen measures 543 (460+83) mm.

Atheris nitschei Tornier.

Atheris nitschei Tornier, Zool. Jahrb. Syst., 15, p. 589, fig., 1902—Mpororo Swamp, Belgian Ruanda-Urundi.

21 (8978, 8983–7, 9890–9904): Lake Bunyoni, Uganda (Heller, 1925).

9 embryos (9905): Lake Bunyoni, Kigezi District, Uganda (Heller, 1925).

Midbody scale-rows 25–29, average 27; ventrals 141–156; anal entire; subcaudals 37–51; labials 9–11. Largest male measures 611 (523+88) mm., largest female 651 (567+84) mm.

This is probably the finest series of this interesting tree-viper in existence though nine of the snakes are embryos just ready for parturition and nine others (No. 9905) are very small embryos; these latter were not utilized in making scale counts. Presumably these two batches of embryos represent the progeny of two of the female adults. It is interesting to observe that the tips of the tails in these young vipers are ivory-white and that three of the embryos have 9-9 labials, four have 10-10, one 11-10, while only one possesses 11-11, tending to show that the higher number may be a development of later life. The sexes can be determined apparently by the subcaudal count, those with over 40 pairs of subcaudals being males, those with less than 40, females; none possessed 40.

Atractaspis bibronii Smith.

Atractaspis bibronii Smith, Illus. Zool. S. Africa, **3**, pl. lxxi, 1849—eastern districts of Cape Colony; Boulenger, Cat. Snakes Brit. Mus., **3**, p. 515, 1896.

1 (12879): Katobwe, Belgian Congo (Zimmer, 1926).

Midbody scale-rows 23; ventrals 235; anal entire; subcaudals 22; labials 5, third and fourth entering the orbit; third lower labial largest. Total length 572 (542+30) mm.

Atractaspis microlepidota Günther.

Atractaspis microlepidota Günther, Ann. Mag. Nat. Hist., (3), **18**, p. 29, pl. vii, fig. 3, 1866—type locality unknown "probably West Africa" errore; Boulenger, Cat. Snakes Brit. Mus., **3**, p. 517, 1896; Meek, Field Mus., Zool. Ser., **1**, p. 179, 1897; Loveridge, Bull. Mus. Comp. Zool., **74**, p. 281, 1933.

1 (375): Harsi Barri, Ethiopia (Akeley, 1896).

Midbody scale-rows 29; ventrals 243; anal entire; subcaudals 32; labials 6, only the fourth entering the orbit; fourth lower labial largest. Total length 663 (610+53) mm. In the last citation given above reasons are advanced for placing certain species in the synonymy of *microlepidota*.

GEKKONIDAE

Hemitheconyx caudicinctus (Duméril).

Stenodactylus caudicinctus Duméril, Rev. Mag. Zool., p. 479, pl. xiii, 1851—Senegal.

Psilodactylus caudicinctus Boulenger, Cat. Liz. Brit. Mus., **1**, p. 230, 1885.

Hemitheconyx caudicinctus Stejneger, North Amer. Fauna, No. 7, p. 163 (footnote), 1893.

1 (11300): 15 miles south of Zungeru, Nigeria (Clark, 1930).

Formerly considered by Boulenger as one of the Eublepharidae, but since that family is no longer considered distinct from the Gekkonidae *Hemitheconyx* must now be placed near *Stenodactylus*. Mr. H. W. Parker has recently described a new species from Somaliland. The Zungeru specimen recorded above agrees closely with two others in the Museum of Comparative Zoology with which it has been compared. Total length 139 (99+40) mm.

Stenodactylus sthenodactylus sthenodactylus (Lichtenstein).

A[scalabotes] sthenodactylus Lichtenstein, Verz. Doubl. Berlin Mus., p. 102, 1823—Egypt and Nubia.

Stenodactylus guttatus Boulenger, Cat. Liz. Brit. Mus., 1, p. 41, 1885.

2 (586): Giza, Egypt (British Museum).

The name *sthenodactylus* of Lichtenstein (1823) antedates *elegans* Fitzinger (1826), *guttatus* Cuvier (1829), and *mauritanicus* Guichenot (1850). The latter name is applicable in a subspecific sense to the geckos from Algeria and Morocco for these possess a less elevated nasal ring than have geckos from Tunis, Tripoli, Egypt, Sudan, and Syria in the Museum of Comparative Zoology. *S. mauritanicus* was described from Aran, Algeria, as was also *S. m. huouxii* Doumergue (1899) which does not appear to be recognizable as a valid race. Both these Giza specimens differ from the description in that the rostral enters the nostril. Two femoral pores are distinguishable in one male, absent in the other. Length of the larger specimen from snout to anus 45 mm., tail missing.

Palmatogecko rangei Andersson.

Palmatogecko rangei Andersson, Jahrb. Nass. Ver. Wiesbaden, 61, p. 299, 1908—Luderitz Bay, Southwest Protectorate.

3 (14807-8, 15454): Namib Desert, Southwest Protectorate (Gaerdes, 1928).

The larger male measures 123 (64+59) mm., the female 124 (63+61) mm.

Gymnodactylus trachyblepharus Boettger.

Gymnodactylus trachyblepharus Boettger, Abh. Senck. Natur. Ges., 9, p. 138, pl. i, fig. 3, 1874—Djebel Haded, near Mogador, Morocco; Boulenger, Cat. Liz. Brit. Mus., 1, p. 34, 1885.

2 (3894-5): Atlas Mountains, Morocco (Riggenbach).

Eight, not seven, upper labials present. Larger specimen measures 105 (45+60) mm.

Cnemaspis dickersoni (Schmidt).

Gonatodes dickersoni Schmidt, Bull. Amer. Mus. Nat. Hist., 39, p. 436, text fig. 6, 1919—Medje, Belgian Congo.

Paragonatodes dickersoni Noble, Amer. Mus. Nov., No. 4, p. 14, 1921.

Cnemaspis dickersoni Loveridge, Proc. Zool. Soc. Lond., p. 822, 1936 (1935).

5 (12750–4): Beni, Belgian Congo (Heller, 1925).

Upper labials 6; lower labials 5–6; transverse rows of ventrals 20–27; enlarged lamellae beneath median toe 4; preanal pores 7–8. Largest specimen, a male, measures 72 (34+38) mm.

I took the opportunity of comparing the above examples of a very distinct species with the two other members of the genus which are in the Museum of Comparative Zoology. As pointed out by Schmidt, the more slender habitus of *dickersoni* immediately distinguishes it from both its allies. Unfortunately our cotype of *quattuorseriatus* Sternfeld lacks a tail but a second specimen recently collected at Mpwapwa, Tanganyika Territory, shows that the two species cannot be distinguished on the basis of four rows of caudal tubercles which may be present or absent in *quattuorseriatus*. The enlarged ventral scales, as compared with the dorsals, is common to all three species. The other three diagnostic characters mentioned by Schmidt hold good. *C. africanus*, of which a series of topotypes are available, is a much larger gecko.

Hemidactylus mabouia (Moreau de Jonnès).

Gecko mabouia Moreau de Jonnès, Bull. Soc. Philom. Paris, p. 138, 1818—Antilles and adjacent mainland.

Hemidactylus mabouia Boulenger, Cat. Liz. Brit. Mus., 1, p. 122, 1885; Meek, Field Mus. Nat. Hist., Zool. Ser., 7, p. 406, 1910.

Hemidactylus brookii Meek (not of Gray), Field Mus. Nat. Hist., Zool. Ser., 7, p. 406, 1910—on steamer in Red Sea.

3 (2318, 2360, 2382): Voi, Kenya Colony (Akeley, 1906).

1 (2392): On steamer in Red Sea (Akeley, 1906).

1 (12279): Mnazi, Tanganyika Territory (Zimmer, 1926).

5 (12294–8): Uleia, Tanganyika Territory (Zimmer, 1926).

2 (12332, 12340): Ulambo, Tanganyika Territory (Zimmer, 1926).

Dorsal rows of conical tubercles 8–12; lamellae under median digit 7–8; femoral pores 18–24 on each side in the seven males. Largest specimen measures 163 (83+80) mm.

Hemidactylus fasciatus Gray.

Hemidactylus fasciatus Gray, Zool. Misc., p. 58, 1831—type locality unknown; Boulenger, Cat. Liz. Brit. Mus., 1, p. 124, pl. xi, fig. 4, 1885.

1 (3892): Fan Topat, French Congo (Bates).

1 (3893): Efulen, Cameroon (Bates).

Lamellae under median digit 7–8. Larger specimen measures 135 (61+74) mm.

Hemidactylus ituriensis Schmidt.

Hemidactylus ituriensis Schmidt, Bull. Amer. Mus. Nat. Hist., **39**, p. 455, pl. xv, fig. 2; pl. xvi; text fig. 7, 1919—Avakubi, Belgian Congo.

1 (12745): Walikale, Belgian Congo (Heller, 1924).

Lamellae under the median digit 9. Length from snout to anus 79 mm., tip of tail missing.

Hemidactylus sinaitus Boulenger.

Hemidactylus sinaitus Boulenger, Cat. Liz. Brit. Mus., **1**, p. 126, 1885—Mount Sinai.

3 (587): Durrur, near Suakin, Sudan (British Museum).

All three differ from the original description in that the rostral does enter the nostril. Anderson has, however, reexamined the type and states that it does enter. Upper labials 9–10; lower labials 6–8; lamellae under median digit 5–7; under fourth digit 6–7; under fourth toe 7–10; preanal pores in both males 4. Larger male measures 42 mm. from snout to anus, tail missing.

Hemidactylus brookii Gray.

Hemidactylus brookii Gray, Zool. Erebus and Terror, pl. xv, fig. 2, 1844—Australia and Borneo; Boulenger, Cat. Liz. Brit. Mus., **1**, p. 128, 1885.

5 (12777–81): Irumu, Belgian Congo (Heller, 1925).

Dorsal rows of keeled tubercles 14–16; lamellae under first digit 2–4; under median digit 5–6; femoral pores 14–15 except No. 12778 which has 3–3. Largest male measures 106 (65+41) mm.

Lygodactylus picturatus picturatus (Peters).

Hemidactylus picturatus Peters, Monatsb. Akad. Wiss. Berlin, p. 115, 1870—Zanzibar.

Lygodactylus picturatus Boulenger, Cat. Liz. Brit. Mus., **1**, p. 161, 1885; Meek, Field Mus. Nat. Hist., Zool. Ser., **7**, p. 406, 1910.

5 (2361, 2384, 2386): Voi, Kenya Colony (Akeley, 1906).

12 (12236–40, 12242, 12249, 12257–61): Lake Manka, Tanganyika Territory (Zimmer, 1926).

Upper labials 6–8, average of 34 sides is 6.5; preanal pores in the ten males 8–10, average 9. Largest specimen, a male, measures 78 (39+39) mm.

Lygodactylus picturatus gutturalis (Bocage).

Hemidactylus gutturalis Bocage, Jorn. Sci. Lisboa, 4, p. 211, 1873—Bissao, Portuguese Guinea.

Lygodactylus gutturalis Boulenger, Cat. Liz. Brit. Mus., 1, p. 161, 1885.

1 (6988): Bunia, Belgian Congo (Heller, 1924).

4 (12755–8): Beni, Belgian Congo (Heller, 1925).

13 (12881–93): Katobwe, Belgian Congo (Zimmer, 1926).

Upper labials 6–8, average of 36 sides 6.9; preanal pores in the five males 7–9, average 7.6. Largest specimen, a female, measures 74 (38+36) mm.

Tarentola mauritanica mauritanica (Linnaeus).

Lacerta mauritanica Linnaeus, Syst. Nat., 1, p. 202, 1758—Mauritania.

Tarentola mauritanicus Boulenger, Cat. Liz. Brit. Mus., 1, p. 196, 1885.

1 (3890): Mogador, Morocco (Riggenbach).

A typical example, measuring 64 mm. from snout to anus; tail missing.

Tarentola annularis (Geoffroy).

Gecko annularis Geoffroy, Descr. de l'Egypte, Rept., p. 130, pl. v, figs. 6 and 7, 1809—Egypt.

Tarentola annularis Boulenger, Cat. Liz. Brit. Mus., 1, p. 197, 1897.

6 (597): Giza, Egypt (Flower).

Upper labials 9–12, average 10. Largest specimen measures 154 (98+56) mm., the tail apparently regenerated.

Pachydactylus mariquensis Smith.

Pachydactylus mariquensis Smith, Illus. Zool. S. Africa, 3, App. p. 3, 1849—interior of South Africa, towards the tropic of Capricorn; Boulenger, Cat. Liz. Brit. Mus., 1, p. 207, 1885.

1 (15541): Lady Frere, Cape Province (Romer, 1929).

Upper labials 7–8; lower labials 7–8; lamellae under median digit 3. Total length 73 (40+33) mm.

Pachydactylus austeni Hewitt.

Pachydactylus austeni Hewitt, Ann. Natal Mus., 5, p. 68, text fig., pl. iv, figs. 1 and 2, 1923—Port Nolloth, Cape Province.

3 (16013–5): Kleinzee, Cape Province (Wecke, 1931).

As Kleinzee is close to Port Nolloth these geckos may be regarded as almost topotypic. One, however, differs from the types in having

the nasorostrals separated by a single row composed of two granules. Upper labials 9–10; lower labials 7–9; lamellae under median digit 3; under fourth toe 3. Largest specimen measures 73 (42+31) mm.

AGAMIDAE

Agama mutabilis Merrem.

Agama mutabilis Merrem, Tent. Syst. Amph., p. 50, 1820—Egypt; Anderson, Zool. Egypt, 1, p. 94, pl. ix, 1898.

1 (620): Cairo, Egypt (British Museum).

Midbody scale-rows 91; pores 24 but in two rows. This male measures 176 (74+102) mm.

Agama flavimaculata (Rüppell).

Trapelus flavimaculatus Rüppell, Neue Wirbelt. Fauna Abyssinia, 2, p. 12, pl. vi, fig. 1, 1835—near Djetta, Arabia.

Agama leucostigma Boulenger (non Reuss), Cat. Liz. Brit. Mus., 1, p. 346, 1885.

2 (590): Between Suez and Ismailia, Egypt (British Museum).

Midbody scale-rows 69–74; preanal pores 9–9. Larger male measures 165 (69+96) mm.

Agama pallida Reuss.

Agama pallida Reuss, Mus. Senck., 1, p. 38, pl. iii, fig. 3, 1834—no locality; Boulenger, Cat. Liz. Brit. Mus., 1, p. 348, 1885.

3 (602): Cairo, Egypt (Flower).

1 (1849): Suez, Egypt (Flower).

Midbody scale-rows 105–136; preanal pores 23–24 in two rows. Largest male measures 160 (71+89) mm.

Agama hispida brachyura Boulenger.

Agama brachyura Boulenger, Cat. Liz. Brit. Mus., 1, p. 350, pl. xxviii, fig. 1, 1885—Cape of Good Hope.

3 (16016–8): Kleinzee, Cape Province (Wecke, 1931).

Midbody scale-rows 84–92; preanal pores 8–11. Largest male measures 206 (106+100) mm.

Agama hispida aculeata Merrem.

Agama aculeata Merrem, Tent. Syst. Amph., p. 53, 1820—Cape of Good Hope; Boulenger, Cat. Liz. Brit. Mus., 1, p. 351, 1885.

2 (3903–4): Benguela, Angola (Ansorge).

6 (15382–7): Cuma, Angola (Hambly, 1929).

Midbody scale-rows 83–93; preanal pores 11–15, the higher number in two rows. Largest male measures 234 (92+142) mm.

Agama atra atra Daudin.

Agama atra Daudin, Hist. Nat. Rept., **3**, p. 349, 1802 type locality unknown; Boulenger, Cat. Liz. Brit. Mus., **1**, p. 352, 1885.

35 (15550): Lady Frere, Cape Province (Romer, 1929).

Midbody scale-rows 102–129, average 116.8; preanal pores of sixteen males 9–13, average 11. Largest female measures 191 (87+104) mm.; a male with this body length has the tail injured. Most of the series are juvenile.

Agama mossambica montana Barbour and Loveridge.

Agama mossambica montana Barbour and Loveridge, Mem. Mus. Comp. Zool., **50**, p. 147, 1928 near Bagilo, Uluguru Mountain, Tanganyika Territory.

1 (12290): Mnazi, Tanganyika Territory (Zimmer, 1926).

3 (12292-3, 12302): Uleia, Tanganyika Territory (Zimmer, 1926).

1 (12327): Mitiangu, Tanganyika Territory (Zimmer, 1926).

2 (12333, 12337): Ulambo, Tanganyika Territory (Zimmer, 1926).

The above specimens are not typical of the race *montana* which was based on a series of forty adults. A male from Mnazi and another from Uleia both attain to a greater length than any mountain specimens and are therefore intermediate between *montana* and the much larger coastal form. As much might be inferred from the altitude of the localities from which they come. In this connection the question arises as to the status of *A. cariniventris* Peters (1874, Monatsb. Akad. Wiss. Berlin, p. 159) which was described from the "Zanzibar Coast," a term in use at that time for the mainland opposite Zanzibar Island. As the collector, Hildebrandt, was known to have visited the Taita Hills and other upland areas it may be that *cariniventris* is applicable to such intermediates as are listed above and is not a strict synonym of *mossambica* as thought by Boulenger in 1885. Its author compared it with *colonorum* (=*agama* Linnaeus). The species was not seen by me during three weeks spent on Mount Mbololo in the Taita Hills.

Midbody scale-rows 61-76, average about 64; preanal pores of five males 6-10, average 8.6. Largest male measures 273 (87+186) mm.

Agama agama agama (Linnaeus).

Lacerta agama Linnaeus (part), Syst. Nat., **1**, p. 207, 1758 "America."
Agama colonorum Boulenger, Cat. Liz. Brit. Mus., **1**, p. 356, 1885.

1 (1589): Gold Coast (Basel Museum).

3 (13130–2): Rhino Camp, Uganda (Zimmer, 1927).

13 (13133–45): Bulukutoni, Uganda (Zimmer, 1927).

Midbody scale-rows 67–77, average 72; upper labials 8–11, average 9; lamellae beneath fourth toe 19–25, average 21; preanal pores of nine males 9–11, average 9. Largest male (Gold Coast) measures 310 (125+185) mm.

The mucros on the dorsal scales of the Gold Coast specimen (which should be typical) are more developed than in any of the Uganda specimens. Andersson (Bihang till K. Svenska Vet.-Akad. Hand., **26**, No. 1, p. 11, 1900) has shown that *Lacerta agama* Linnaeus is identifiable and should be known as *Agama agama*, taking precedence over Daudin's well-known name of *A. colonorum*. At my request, Count Gyldenstolpe very kindly counted the midbody scale-rows in one of the Linnaean cotypes of *A. agama* preserved in the Royal Swedish Museum, and found them to number 75. The probability is that it came from the Cameroon or Gaboon region and I suggest that the type locality be restricted to the Cameroon.

It will be noticed that Boulenger (l.c.) gives the number of midbody scale-rows for *A. colonorum* as 60 to 80, an extraordinarily wide range for any species of agama in this section. Experience resulting from counting many hundreds of East African members of the genus has shown me that the variation of any one race is generally ten, rarely as many as thirteen, in a given area.

The typical form has usually been considered to have a distribution from Senegal to the western foot of Mount Elgon, Uganda. The following scale counts show, however, that the number decreases from east to west with a falling off west of the Gold Coast sufficiently marked to justify the recognition of a race in that region.

The names *colonorum* Daudin (Africa), *occipitalis* Gray (Africa), *congica* Peters (Chinchoxo), *picticauda* Peters (Adda Foa, Accra; Cameroon) appear to be synonymous with the typical form. For the western race I believe that the name *savatieri* Rochebrune (with Bathurst, Gambia, as restricted type locality) may be used. Mons. Angel informs me that the type is not in the Paris Museum. It is probably lost unless preserved in Senegal. The description accords reasonably well, the figure of the head-shields very closely. The coloring is doubtful. As stated by Boulenger, the work of this author is of the worst. Some recently taken scale counts are given below; they are arranged according to locality, east to west.

A. a. agama (Linnaeus).

13 from Budadiri, east Uganda, range 74–84 with average 79.

13 from Bulukutoni, northwest Uganda, range 67–77, average 72.

13 from Belgian Congo localities, range 64–74 with average 68.
13 from French West Africa, range 62–74 with average 67.
13 from Cameroon, range 72–84 with average 76.
1 from Gold Coast, range 70 with average 70.

A. a. savatieri Rochebrune.
11 from Liberia range 60–64 with average 62.
3 from Senegal range 58–64 with average 60.

Agama agama subsp.

5 (15076–80): Bisan River, Ethiopia (Albrecht, 1929).

Midbody scale-rows 70–77, average 74; upper labials 9–11, average 10; lamellae beneath fourth toe 19–20; preanal pores of five males 10–13, average 11. Largest male measures 115 mm. from snout to anus, tail damaged.

These five agamas are intermediate in position between *A. a. agama* and *A. a. lionotus*. From the former they differ in the much smoother dorsals which are only very faintly keeled; from *lionotus* they differ in the shorter nuchal crest. It is probable, however, that they should be referred to *lionotus*, the Bisan River being in extreme southern Ethiopia.

Agama agama lionotus Boulenger.

Agama lionotus Boulenger, Proc. Zool. Soc. Lond., p. 214, pl. viii, 1896—southeast of Lake Rudolph, Kenya Colony.

Agama colonorum Meek (not Daudin), Field Mus. Nat. Hist., Zool. Ser., **7**, p. 407, 1910.

20 (2313–7, 2319–20, 2346–8, 2359, 2377, 2387): Voi, Kenya Colony (Akeley, 1906).

27 (2321–5, 2334–45): Lukenya, Kenya Colony (Akeley, 1906).

3 (8872–4): Tsavo, Kenya Colony (Heller, 1926).

Midbody scale-rows 70–80 except for one Tsavo agama with 67, average 77; upper labials 9–13, average 10.3; lamellae beneath fourth toe 17–25, average 21; preanal pores of 28 males 11–17, average 13. Largest male measures 125 mm. from snout to anus, tail damaged.

Agama agama usambarae Barbour and Loveridge.

Agama colonorum usambarae Barbour and Loveridge, Mem. Mus. Comp. Zool., **50**, p. 150, pl. ii, fig. 1, 1928—Soni, East Usambara Mountains, Tanganyika Territory.

8 (12280–7): Mnazi, Tanganyika Territory (Zimmer, 1926).

Midbody scale-rows 70–78, average 73; upper labials 9–11, average 10.1; lamellae beneath fourth toe 20–21, average 20.6; preanal pores of three males 10–13, average 11. Largest male measures 325 (122+203) mm.

This form is probably only to be distinguished from the foregoing on color grounds. The head of *lionotus* from Mombasa just north of the Usambara Mountains, is gamboge or mustard-yellow above, its throat brick-red; *usambarae*, of which the above series were named paratypes, on the other hand, has the top of the head as well as the throat of a bright crimson-lake hue. As these bright colors fade out on preservation it remains to be seen whether this form can be retained. The genus *Agama* is badly in need of a thorough revision.

Agama planiceps planiceps Peters.

Agama planiceps Peters, Monatsb. Akad. Wiss. Berlin, p. 15, 1862 - New Barmen, Hereroland; Boulenger, Cat. Liz. Brit. Mus., 1, p. 358, 1885.

16 (15399 414): Cuma, Angola (Hambly, 1929).

Midbody scale-rows 80 90, except No. 15403 which has 74, average 84; upper labials 9–11, average 10; lamellae beneath fourth toe 21–26, average 23; preanal pores of nine males 12–14 (except for one agama which has a second row, the two giving a total of 24, this supernumerary row is omitted from the average), average 12. Largest male measures 130 mm. from snout to anus, tail damaged.

Agama planiceps caudospinosa Meek.

Agama caudospinosa Meek, Field Mus. Nat. Hist., Zool. Ser., 7, p. 407, 1910 - Lake Elmenteita, Kenya Colony.

2 (2311–2): Lake Elmenteita, Kenya Colony (Akeley, 1906).

3 (2326 7, 6448): Gilgil, Kenya Colony (Akeley, 1906).

Midbody scale-rows 74 83, average 80; upper labials 9 12, average 10.7; lamellae beneath fourth toe 19–20, average 20; preanal pores of four males 9–12, average 10. Largest male measures 112 mm. from snout to anus, tail damaged. No. 2312 is the type.

Agama atricollis Smith.

Agama atricollis Smith, Illus. Zool. S. Africa, 3, App. p. 14, 1849– Natal; Boulenger, Cat. Liz. Brit. Mus., 1, p. 358, 1885; Meek, Field Mus. Nat. Hist., Zool. Ser., 7, p. 408, 1910.

5 (2309–10, 2328–30): Lake Elmenteita, Kenya Colony (Akeley, 1906).

3 (2331–2, 2431): Nairobi, Kenya Colony (Akeley, 1906).

3 (6454–6): Gilgil, Kenya Colony (Akeley, 1906).

2 (6978, 6980): Bunia, Belgian Congo (Heller, 1924).

2 (8988–9): Bambuni, Belgian Congo (Heller, 1925).

2 (12309–10): Uleia, Tanganyika Territory (Zimmer, 1926).

4 (12334, 12338–9, 12341): Ulambo, Tanganyika Territory (Zimmer, 1926).

2 (12734–5): Gendoa River, Ethiopia (Osgood, 1927).

14 (12764–7, 12809–17, 12833): Near Beni, Belgian Congo (Heller, 1925).

11 (15388–98): Cuma, Angola (Hambly, 1929).

Midbody scale-rows 79–114, but whole series not counted; scales on the vertebral region usually irregularly enlarged but in some the median rows tend to form a definite longitudinal vertebral band of enlarged scales. This is especially noticeable in the male from Metemma, Ethiopia (but not in the least in the female from the same locality); it seems as if these two Ethiopian agamas are more or less intermediate between *atricollis* and *annectens*, differing from the latter in possessing ventrals considerably smaller than the enlarged dorsals, also in coloration and in other minor points; in some Angolan specimens the enlarged scales along the vertebral line also tend to form a well differentiated region; ventrals smooth or keeled.

Nostril pierced below the canthus rostralis in 42 specimens, on it in 5; labials 9–13, average 10.9; lamellae beneath the median digit 16–23, average 18.6; lamellae beneath the fourth toe 18–27, average 21.9; preanal pores in 25 males are in two or three rows totaling 13–36, average 20.8. Belly occasionally bears reticulate markings. Largest male measures 280 (142+138) mm.

Agama cyanogaster (Rüppell).

Stellio cyanogaster Rüppell, Neue Wirbelt. Fauna Abyssinia, 2, p. 10, pl. v, 1835–Massaua and the Abyssinian coast (i.e. Massawa, Eritrea).

Agama cyanogaster Boulenger, Cat. Liz. Brit. Mus., 1, p. 358, 1885.

2 (3905–6): Harar, Ethiopia (Kristensen).

2 (12522–3): Lake Shala, Ethiopia (Osgood, 1927).

The following data are based upon the above and a pregnant female from Harar, Ethiopia, in the Museum of Comparative Zoology (No. 8064).

Midbody scale-rows 98–114, average 105; scales on the vertebral region usually irregularly enlarged but in No. 12522 the four median rows form a longitudinal, vertebral band in which the two outermost

rows are larger than the innermost pair but are otherwise more or less uniformly enlarged; ventral scales smooth or feebly keeled.

Nostril pierced below the canthus rostralis in 4 specimens, on it in 1; labials 9–12, average 10.6; lamellae beneath the median digit 17–21, average 18; lamellae beneath the fourth toe 18–22, average 20; preanal pores in two males are in two rows totaling 17–19, average 18. The belly is immaculate in one adult male and in two females; it is reticulated with blue lines like those on the throat in the remaining male and female. One male measures 147 (62+85) mm.; the largest female (M.C.Z.) measures 151 (70+81) mm.

The fact that this small female is pregnant shows beyond question that *A. cyanogaster* is distinct from *A. atricollis*. It is extremely difficult to differentiate the two species (except on size). With this object in view Mr. Frederick Grinnell spent several days in exploring the possibilities of various characters. I am indebted to him for collecting the statistical data embodied in the preceding paragraphs. The position of the nostril employed by Boulenger in 1885 is not diagnostic.

Uromastix ocellatus Lichtenstein.

Uromastix ocellatus Lichtenstein, Verz. Doubl. Mus. Berlin, p. 107, 1823—Nubia; Anderson, Zool. Egypt, 1, p. 127, pl. xii, 1898.

1 (619): Suakin, Sudan (British Museum).

This specimen is almost certainly one of those mentioned by Anderson. Total length 243 (128+115) mm.

ZONURIDAE

Zonurus macropholis Boulenger.

Zonurus macropholis Boulenger, Ann. S. Afr. Mus., 5, p. 494, 1910—Little Namaqualand; Power, Ann. Transvaal Mus., 14, p. 16, 1930.

3 (16019–21): Kleinzee, Cape Province (Wecke, 1931).

Transverse rows of scales from occiput to base of tail 16–18; longitudinal rows of ventrals 10–12; femoral pores 9–10. Largest specimen measures 119 (67+52) mm. As recently as 1930, Power, in his review of the South African zonures, remarked that *macropholis* was still known only from the type.

Zonurus cordylus cordylus (Linnaeus).

Lacerta cordylus Linnaeus, Syst. Nat., 1, p. 202, 1758—Africa.

Zonurus cordylus Boulenger, Cat. Liz. Brit. Mus., 2, p. 256, 1885.

3 (15545–7): Lady Frere, Cape Province (Romer, 1929).

Transverse rows of scales from occiput to base of tail 29; longitudinal rows of ventrals 12; femoral pores 6-7. Largest perfect specimen measures 145 (70+75) mm.

VARANIDAE

Varanus albigularis angolensis Schmidt.

Varanus albigularis angolensis Schmidt, Ann. Carnegie Mus., **22**, p. 10, pl. ii, 1933—Gauca, Bihé, Angola.

1 (12971): Kabengere, Belgian Congo (Zimmer, 1926).

This specimen, a paratype, has not been examined. The skin is very dry and hard and its approximate measurements have been kindly furnished by Mr. K. P. Schmidt as follows: Total length 900 (350+550) mm. The Somaliland Protectorate monitors referred to *albigularis* by Meek are mentioned below.

Varanus ocellatus Heyden.

Varanus ocellatus Heyden, in Rüppell, Reise nörd Afrika, p. 21, pl. vi, 1827 Kordofan, Sudan; Boulenger, Cat. Liz. Brit. Mus., **2**, p. 308, 1885.

Varanus albigularis Meek (not Daudin), Field Mus., Zool. Ser., **1**, p. 181, 1897.

1 (378): Betteran, Somaliland Protectorate (Akeley, 1896).

This is one of the two specimens referred to *albigularis* by Meek and re-identified as *ocellatus* by Schmidt. As it is on exhibition it has not been examined. The second specimen has not been found.

Varanus niloticus (Linnaeus).

Lacerta nilotica Linnaeus, Syst. Nat., 12th ed., **1**, p. 369, 1766—Egypt.

Varanus niloticus Boulenger, Cat. Liz. Brit. Mus., **2**, p. 318, 1885; Meek, Field Mus. Nat. Hist., Zool. Ser., **7**, p. 409, 1910.

1 (12300): Uleia, Tanganyika Territory (Zimmer, 1926).

1 (12737): Gendoa River, Ethiopia (Osgood, 1927).

1 (12975): Katobwe, Belgian Congo (Zimmer, 1926).

The Nilotic monitor from Kisumu, Kenya Colony, mentioned by Meek cannot be located, but there is no reason for doubting the identification as these lizards are abundant on the shores of Lake Victoria and I have seen them at Kisumu. The specimens listed above are young; the Ethiopian monitor has had the body skinned out.

LACERTIDAE

Lacerta jacksoni Boulenger.

Lacerta jacksoni Boulenger, Proc. Zool. Soc. Lond., p. 96, pl. x, 1899—Mau Ravine, Kenya Colony; Boulenger, Monog. Lacertid., **1**, p. 295, 1920.

1 (9863): Lake Bunyoni, Uganda (Heller, 1925).

Ventral plates in 8 longitudinal series; lamellae under fourth toe 22; femoral pores 18-18. Length from snout to anus 78 mm., tail missing.

Algiroides boulengeri Peracca.

Algiroides boulengeri Peracca, Atti. Acc. Torin, **52**, p. 351, 1917—Fort Portal, Uganda; Boulenger, Monog. Lacertid., **1**, p. 351, 1920.

1 (12182): Lake Bunyoni, Uganda (Heller, 1925).

Longitudinal dorsal scale-rows 33; lamellae beneath fourth toe 16; femoral pores 7-8. Length from snout to anus 29 mm., tail missing.

Latastia longicaudata longicaudata (Reuss).

Lacerta longicaudata Reuss, Mus. Senckenb., **1**, p. 29, 1834—Abyssinia.

Latastia longicaudata Boulenger, Monog. Lacertid., **2**, p. 25, 1921.

1 (615): Suakin, Sudan (British Museum).

Longitudinal dorsal scale-rows 57; transverse ventral scale-rows 30; femoral pores 12. Total length 391 (102+289) mm.

Latastia longicaudata revoili (Vaillant).

Eremias revoili Vaillant, Miss. Révoil Pays Comal., Rept., p. 20, pl. iii, fig. 2, 1882—Somaliland.

Latastia longicaudata var. *revoili* Boulenger, Monog. Lacertid., **2**, p. 30, 1921.

1 (8871): Tsavo, Kenya Colony (Heller, 1921).

4 (12234-5, 12252-3): Lake Manka, Tanganyika Territory (Zimmer, 1926).

1 (12274): Mnazi, Tanganyika Territory (Zimmer, 1926).

Longitudinal dorsal scale-rows 59-81; transverse ventral scale-rows 26-28; femoral pores 8-10. Largest specimen measures 351 (87+264) mm.

Philochortus hardeggeri (Steindachner).

Latastia hardeggeri Steindachner, Ann. Naturhist. Hofmus. Wien, **6**, p. 371, pl. xi, 1891—Harar on the way from Heusa, Ethiopia.

Latastia carinata Meek (not of Peters), Field Mus., Zool. Ser., **1**, p. 179, 1897.

Philochortus hardeggeri Boulenger, Monog. Lacertid., **2**, p. 12, 1921.

1 (371): Haud, Ethiopia (Akeley, 1896).

Longitudinal dorsal scale-rows 25; lamellae under fourth toe 28; femoral pores 12. Total length 173 (57+116) mm.

Acanthodactylus pardalis pardalis (Lichtenstein).

Lacerta pardalis Lichtenstein, Verz. Doubl. Mus. Berlin, p. 99, 1823–Egypt.

Acanthodactylus pardalis Boulenger, Monog. Lacertid., 2, p. 62, 1921.

3 (608): Alexandria, Egypt (Flower).

Longitudinal dorsal scale-rows 59–62; longitudinal ventral scale-rows 12; lamellae under fourth toe 18–20; subocular not bordering the mouth. Largest specimen measures 149 (60+89) mm.

Acanthodactylus boskianus asper (Audouin).

Lacerta asper Audouin, Descr. l'Egypte, Rept., Suppl., p. 174, pl. i, fig. 10, 1829– Egypt.

Acanthodactylus boskianus var. *asper* Boulenger, Monog. Lacertid., 2, p. 86, 1921.

10 (593, 1856): Tel el Amarna, Egypt (British Museum).

Longitudinal dorsal scale-rows 29–38; subocular not bordering the mouth; first supraocular not divided; femoral pores 17–22. Largest perfect specimen measures 200 (66+134) mm.

Acanthodactylus scutellatus scutellatus (Audouin).

Lacerta scutellata Audouin, Descr. l'Egypte, Rept., Suppl., p. 172, pl. i, fig. 7, 1829—Egypt.

Acanthodactylus scutellatus Boulenger, Monog. Lacertid., 2, p. 97, 1921.

2 (613): Between Suez and Ismailia, Egypt (British Museum).

Longitudinal dorsal scale-rows 77–79; longitudinal ventral scale-rows 16; lamellae under fourth toe 23–26. Largest specimen measures 149 (54+95) mm.

Eremias spekii spekii Günther.

Eremias spekii Günther, Ann. Mag. Nat. Hist., (4), 9, p. 381, 1872 Unyamwezi, Tanganyika Territory; Meek, Field Mus. Nat. Hist., Zool. Ser., 7, p. 409, 1910; Boulenger, Monog. Lacertid., 2, p. 235, 1921.

7 (2363, 2379): Voi, Kenya Colony (Akeley, 1906).

4 (12241, 12254–6): Lake Manka, Tanganyika Territory (Zimmer, 1926).

1 (12273): Mnazi, Tanganyika Territory (Zimmer, 1926).

Longitudinal dorsal scale-rows 61–75; longitudinal ventral scale-rows 6; lamellae under fourth toe 22–26; subocular borders the lip. Largest specimen measures 153 (50+103) mm.

Eremias mucronata (Blanford).

Acanthodactylus mucronatus Blanford, Zool. Abyss., p. 453, fig., 1870—Anseba, Eritrea.

Eremias brenneri Meek (not of Peters), Field Mus., Zool. Ser., 1, p. 181, 1897.

Eremias mucronata Boulenger, Monog. Lacertid., 2, p. 244, 1921.

2 (368): Betteran, Somaliland Protectorate (Akeley, 1896).

3 (610): Suakin, Sudan (British Museum).

Longitudinal dorsal scale-rows 63–75; longitudinal ventral rows 6–8; subocular borders the lip in the Suakin series but not in the lizards from Betteran. Boulenger has, however, pointed out that this is an inconstant character. Largest specimen measures 152 (48+104) mm.

Eremias guttulata guttulata (Lichtenstein).

Lacerta guttulata Lichtenstein, Verz. Doubl. Mus. Berlin, p. 101, 1823—Egypt and Nubia.

Eremias guttulata Boulenger, Monog. Lacertid., 2, p. 258, 1921.

2 (612): Karnak, Egypt (British Museum).

1 (3964): El Kantara, Algeria (Buxton, 1913).

Longitudinal dorsal scale-rows 44–46; longitudinal ventral scale-rows 8–10; subocular bordering the lip. Largest specimen measures 156 (45+111) mm.

Eremias rubropunctata (Lichtenstein).

Lacerta rubropunctata Lichtenstein, Verz. Doubl. Mus. Berlin, p. 100, 1823—Egypt and Nubia.

Eremias rubropunctata Boulenger, Monog. Lacertid., 2, p. 276, 1921.

3 (591): Giza, Egypt (British Museum).

Longitudinal dorsal scale-rows 53–59; longitudinal ventral scale-rows 12; rostral in contact with the frontonasal. Largest specimen measures 126 (45+81) mm.

Eremias lineo-ocellata Duméril and Bibron.

Eremias lineo-ocellata Duméril and Bibron, Erpét. Gén., 5, p. 314, 1831—South Africa; Boulenger, Monog. Lacertid., 2, p. 289, 1921.

3 (15542–4): Lady Frere, Cape Province (Romer, 1929).

Longitudinal dorsal scale-rows 61–69; longitudinal ventral scale-rows 12; lamellae under fourth toe 24–26; femoral pores 12–14. Largest specimen measures 125 (42+83) mm.

Scapteira reticulata Bocage.

Scapateira reticulata Bocage, Ann. Mag. Nat. Hist., (3), **20**, p. 225, 1867 — Mossamedes, Angola.

Scaptira reticulata Boulenger, Monog. Lacertid., **2**, p. 357, 1921.

1 (15452): Namib Desert, Southwest Protectorate (Gaerdes, 1928).

Longitudinal dorsal scale-rows 56; longitudinal ventral scale-rows 16; femoral pores 20–22. Total length 141 (51+90) mm. At the time that Boulenger wrote the second volume of his monograph (1921) this rare lizard was still unrepresented in the British Museum collection.

Scapteira ctenodactyla (Smith).

Lacerta ctenodactyla A. Smith, Mag. Nat. Hist., (2), **2**, p. 93, 1838 — Great Namaqualand, Southwest Africa.

Scaptira ctenodactyla Boulenger, Monog. Lacertid., **2**, p. 358, 1921.

1 (1857): Port Nolloth, Cape Province (British Museum).

Longitudinal dorsal scale-rows 79; longitudinal ventral scale-rows 22; femoral pores 30. Total length 194 (80+114) mm.

Aporosaura anchietae (Bocage).

Pachyrhynchus anchietae Bocage, Ann. Mag. Nat. Hist., (3), **20**, p. 227, fig., 1867 — Rio Croco, Mossamedes, Angola.

Aporosaura anchietae Boulenger, Monog. Lacertid., **2**, p. 376, 1921.

1 (15453): Namib Desert, Southwest Protectorate (Gaerdes, 1928).

Longitudinal dorsal scale-rows 170; longitudinal ventral scale-rows 38. Total length 109 (49+60) mm. male.

Holaspis guentheri Gray.

Holaspis guentheri Gray, Proc. Zool. Soc. Lond., p. 153, pl. xx, fig. 1, 1863 — habitat unknown; Boulenger, Monog. Lacertid., **2**, p. 377, 1921.

1 (1858): Benito River, Spanish Guinea (British Museum).

1 (3963): Bitye, Cameroon (Bates).

1 (12299): Uleia, Tanganyika Territory (Zimmer, 1926).

Longitudinal dorsal scale-rows 65–69; longitudinal ventral scale-rows 6; femoral pores 18–21. Longest specimen measures 102 (50+52) mm. The Uleia record is of exceptional interest for it shows that this lizard is able to live at an altitude considerably below 2,000 feet in East Africa. Traces of rain forest still exist in the vicinity of Uleia though the region has long ago undergone deforestation and is mostly given over to dry bush.

GERRHOSAURIDAE

Gerrhosaurus major major Duméril.

Gerrhosaurus major Duméril, Cat. method. coll. Rept., Paris, p. 139, 1851—Zanzibar; Boulenger, Cat. Liz. Brit. Mus., 3, p. 121, 1887; Meek, Field Mus. Nat. Hist., Zool. Ser., 7, p. 409, 1910.

1 (2385): Voi, Kenya Colony (Akeley, 1906).

Transverse dorsal scale-rows 34; longitudinal dorsal scale-rows 18 (not 12 as in Meek); longitudinal ventral scale-rows 9 (not 10 as in Meek); frontonasal narrowly *separated* from the rostral. In other respects Meek's detailed description and measurements of this young specimen are correct.

Gerrhosaurus major zechi Tornier.

Gerrhosaurus maior zechi Tornier, Beiheft, Arch. Naturg., 67, p. 74, 1901—Kete Kratje, Togoland.

Gerrhosaurus zechi Schmidt, Bull. Amer. Mus. Nat. Hist., 39, p. 519, text fig. 21, 1919.

1 (15074): Bisan River, Ethiopia (Albrecht, 1929).

Transverse dorsal scale-rows 36; longitudinal dorsal scale-rows 18; longitudinal ventral scale-rows 10; femoral pores 13. Total length 422 (192+230) mm.

As a result of obtaining thirty-one *zechi* at Mangasini in central Tanganyika I am inclined to recognize it as a race of *major*. The Bisan River specimen is the first record of the occurrence of *zechi* in Ethiopia known to me; it makes it still more probable that *zechi* will prove to be a synonym of *bottegoi* Del Prato (1892) from Eritrea as has been suggested by Schmidt (1919). The Bisan River lizard does not appear to differ from the Mangasini series.

Gerrhosaurus flavigularis flavigularis Wiegmann.

Gerrhosaurus flavigularis Wiegmann, Isis, p. 379, 1828—"Africa Merid. Krebs"; Boulenger, Cat. Liz. Brit. Mus., 3, p. 122, 1886; Meek, Field Mus. Nat. Hist., Zool. Ser., 7, p. 409, 1910.

3 (2374–5): Nairobi, Kenya Colony (Akeley, 1906).

1 (12275): Mnazi, Tanganyika Territory (Zimmer, 1926).

Transverse dorsal scale-rows 57–59; longitudinal dorsal scale-rows 22; longitudinal ventral scale-rows 8; femoral pores 12–17; prefrontals in contact in the Nairobi lizards, separated in the Mnazi specimen. Largest specimen measures 457 (147+310) mm.

Gerrhosaurus flavigularis nigrolineatus Hallowell.

Gerrhosaurus nigro-lineatus Hallowell, Proc. Acad. Nat. Sci. Phila., p. 49, 1857—Gaboon.

Gerrhosaurus nigrolineatus Boulenger, Cat. Liz. Brit. Mus., 3, p. 122, 1887.

2 (3961-2): Gaboon, French Congo (Ansorge).

12 (15370–81): Cuma, Angola (Hambly, 1929).

Transverse dorsal scale-rows 54–60; longitudinal dorsal scale-rows 22–24; longitudinal ventral scale-rows 8; laterals faintly keeled, a few almost smooth; femoral pores 13–18. Longest specimen (Gaboon) measures 292 (156+136) mm.

SCINCIDAE

Mabuya maculilabris (Gray).

Euprepis maculilabris Gray, Cat. Liz. Brit. Mus., p. 114, 1845—West Africa.

Mabuia maculilabris Boulenger, Cat. Liz. Brit. Mus., 3, p. 164, pl. ix, fig. 2, 1887.

Mabuya maculilabris Barbour and Loveridge, Mem. Mus. Comp. Zool., 50, p. 157, 1928.

1 (3971): Sese Islands, Lake Victoria, Uganda.

1 (3972): 4,500 ft., Mount Ruwenzori, Uganda (Ruwenzori Expedition).

1 (6981): Bunia, Belgian Congo (Heller, 1924).

1 (6987): Lake Kivu, Belgian Congo (Heller, 1924).

6 (8995-9000): Belgian Congo (Heller, 1925).

3 (12291, 12303, 12312): Uleia, Tanganyika Territory (Zimmer, 1926).

31 (12772): Beni, Semliki, Belgian Congo (Heller, 1925).

4 (12773–6): Irumu, Belgian Congo (Heller, 1925).

1 (12871): Katobwe, Belgian Congo (Zimmer, 1926).

2 (12895, 12901): Kabengere, Belgian Congo (Zimmer, 1926).

The data available from this very fine series of a difficult species had best be presented in tabular form. The localities are arranged as far as is possible from west to east.

Locality	Number of specimens	Greatest head and body length	Longest tail	Midbody scale-rows	Number of supraciliaries	Keels on scales
Katobwe	1	87	127	32	5	9
Kabengere .. .	2	79	.	32–34	5	5–7
Lake Kivu. ...	1	74	156	36	5	7
Ruwenzori . . .	1	56	90	32	5	5
Bambuni.......	6	85	159	32–34	5	5
Beni	31	83	175	32–34	4–6	5–7
Bunia	1	86	...	32	5	9
Sese Islands. ...	1	73	. .	34	5	7
Uleia	3	86	169	30	4–5	7–9

At first glance it would appear that the skinks from the east of the great lakes (i.e. Uleia, Tanganyika Territory) could be separated from western specimens on the basis of the smaller number of scale-rows. Unfortunately the position is complicated by numerous individuals occurring in East Africa with 32 midbody scale-rows, occasionally even 34 (Ujiji). Undoubtedly there is a tendency to reduction as one proceeds eastwards and for such the name *boulengeri* proposed by Sternfeld is available. The position is complicated by the presence in surviving rain forest, chiefly on mountains but also on the coast, of a big-bodied form with 34–38 scale-rows, for which I have employed the name *comorensis*. There is much to be done to elucidate the relationship of *maculilabris* and possible forms. Largest specimen measures 214 (87+127) mm.

Mabuya polytropis Boulenger.

Mabuia polytropis Boulenger, Ann. Mag. Nat. Hist., (7), **12**, p. 433, 1903 Benito River, Gaboon.

2 (17041–2): Batan, Cameroon (University of Chicago, 1903).

Midbody scale-rows 32; dorsals with 9–11 keels; supraciliaries 6–8, the latter being unusually high. Larger specimen measures 182 (90+92) mm. but its tail is obviously regenerated for the smaller skink has a tail of 142 mm.

Mabuya blandingii (Hallowell).

Euprepes blandingii Hallowell, Proc. Acad. Nat. Sci. Phila., p. 58, 1844 Liberia.

Euprepis raddoni Gray, Cat. Liz. Brit. Mus., p. 112, 1845 West Africa.

Euprepes frenatus Hallowell, Proc. Acad. Nat. Sci. Phila., p. 50, 1857 · Liberia.

Mabuia raddonii Boulenger, Cat. Liz. Brit. Mus., **3**, p. 165, 1887.

Mabuya raddoni Schmidt, Bull. Amer. Mus. Nat. Hist., **39**, p. 534, 1919.

2 (3973–4): Ogowe River, French Congo (Ansorge).

1 (3975): Lambarene, Ogowe River, French Congo (Ansorge).

1 (3976): Efulen, Cameroon (Bates).

2 (17043–4): Batan, Cameroon (University of Chicago, 1903).

Midbody scale-rows 28; dorsals tricarinate; supraciliaries 5–7; supranasals separate and prefrontals in contact except in the Lambarene skink. Largest specimen measures 158 (70+88) mm.

Boulenger erroneously gives the date of Hallowell's *blandingii* as 1845 and so gives preference to Gray's *raddoni;* the latter has been in general use ever since. Mr. W. Wedgewood Bowen, formerly of the

Philadelphia Academy of Natural Science, informs me that Hallowell's paper was certainly "published on or before July 19, 1844." In 1905, however, Boulenger revived Hallowell's name *albilabris* for Gaboon specimens in which the prefrontals are in contact. Schmidt (l.c., p. 535) doubted the wisdom of this procedure and after carefully going into the matter I agree entirely with him. Hallowell, it will be noted, found both types in his Liberian material and proposed names for those in which the prefrontals are separated (*blandingii*) as well as for those in which they are in contact (*frenatus*). Of twenty-two Liberian specimens in the Museum of Comparative Zoology, ten have the prefrontals in contact and twelve have them separated; the supranasals are separated in all except two. These proportions from the west of the range are closely paralleled by the data given by Schmidt for nineteen skinks from the Belgian Congo in the east of its range.

Liberian skinks from one locality have supraciliaries varying from 5 to 7, some specimens in fact having 5 on one side of the head and 7 on the other; the limb length is as variable in this species as in *M. varia* and not a good specific criterion, varying in one locality so as to include both *blandingii* and *affinis* though the latter is a distinct species. In our Liberian series the midbody scale-rows range from 28 to 33, in Schmidt's Congo specimens from 28 to 34.

It is instructive to arrange the data of the types which are regarded as synonyms, geographically from west to east. Eventually some of them may prove recognizable as racial forms.

Date	Type locality	Species	Midbody scale-rows	Supranasals	Prefrontals
1872	Portuguese Guinea	*gracilis*	32	separated	separated
1885	Sierra Leone	*pantaenii*	29	contact	separated
1844	Liberia	*blandingii*	30	contact	separated
1857	Liberia	*frenatus*[1]	33	?	contact
1864	Gold Coast	*aeneofuscus*	30	separated	separated
1857	Gaboon	*albilabris*[1]	?	separated	contact
1901	Gaboon: Benito R.	*benitensis*	28–30	contact	separated
1886	Saint Thomas Id.	*cupreus*	30	separated	separated
1845	West Africa	*raddoni*	.	contact	separated

Mabuya brevicollis (Wiegmann).

Euprepes brevicollis Wiegmann, Arch. Naturg., p. 133, 1837—Abyssinia (Ethiopia).

Mabuia brevicollis Boulenger, Cat. Liz. Brit. Mus., 3, p. 169, 1887; Meek, Field Mus. Nat. Hist., Zool. Ser., 7, p. 410, 1910; Loveridge, Bull. U. S. Nat. Mus., **151**, p. 69, 1929.

2 (2349, 2353): Voi, Kenya Colony (Akeley, 1906).

[1] Mr. H. W. Fowler informs me that the types of these two species cannot be located in the collection of the Philadelphia Academy.

2 (2372–3): Lukenya, Kenya Colony (Akeley, 1906).

1 (2376): Athi River, Kenya Colony (Akeley, 1906).

Midbody scale-rows 32–36; supraciliaries 5–6; supranasals (some damaged) in contact or separated; prefrontals in contact in three specimens, separated in two. Largest specimen measures 134 mm. from snout to anus, tail missing.

Mabuya megalura (Peters).

Euprepes (Mabuia) megalura Peters, Monatsb. Akad. Wiss. Berlin, p. 204, pl. ii, fig. 4, 1878—Taita, Kenya Colony.

Mabuia megalura Boulenger, Cat. Liz. Brit. Mus., 3, p. 195, 1887; Meek, Field Mus. Nat. Hist., Zool. Ser., 7, p. 411, 1910.

1 (2358): Voi, Kenya Colony (Akeley, 1906).

2 (2365): Athi Plains, Kenya Colony (Akeley, 1906).

1 (2366): Lukenya, Kenya Colony (Akeley, 1906).

1 (12517): Allata, Ethiopia (Osgood, 1927).

1 (12527): Ethiopia (Osgood, 1927).

1 (12528): Gedeb Mountains, Ethiopia (Osgood, 1926).

Midbody scale-rows 24–28, the previous known range (24–27) occurring in Nairobi specimens; only the Allata skink has 28 in the above series. Largest specimen measures 253 (68+185) mm.

Mabuya quinquetaeniata quinquetaeniata (Lichtenstein).

Scincus quinquetaeniata Lichtenstein, Verz. Doubl. Mus. Berlin, p. 103, 1823—Egypt and Nubia.

Mabuia quinquetaeniata Boulenger, Cat. Liz. Brit. Mus., 3, p. 198, 1887; Meek, Field Mus. Nat. Hist., Zool. Ser., 7, p. 410, 1910; Loveridge, Bull. U. S. Nat. Mus., **151**, p. 71, 1929.

3 (12708–9, 12713): West of Lake Tana, Ethiopia (Osgood, 1927).

4 (13124–7): Bulukutoni, Uganda (Zimmer, 1927).

6 (15081–6): Bisan River, Ethiopia (Albrecht, 1929).

Midbody scale-rows 38–42, Ethiopian specimens having 38, Ugandan 38–42. For a discussion of the difficulty of recognizing a southern race (for which the name *margaritifer* Peters is available) see my remarks in the 1929 citation given above.

Mabuya quinquetaeniata obsti Werner.

Mabuia obsti Werner, Mitt. Nat. Mus. Hamburg, **30**, p. 43, 1913—Kwa Mtoro, Central Province, Tanganyika Territory.

9 (2350, 2354–5, 2361–2): Voi, Kenya Colony (Akeley, 1906).

Midbody scale-rows 40–46. Largest male measures 234 (91+143) mm., largest female 188 (91+97) mm., but unfortunately her tail is regenerated.

Mabuya varia varia (Peters).

Euprepes (Euprepis) varius Peters, Monatsb. Akad. Wiss. Berlin, p. 20, 1867—Tete, Mozambique.

Mabuia varia Boulenger, Cat. Liz. Brit. Mus., 3, p. 202, 1887; Meek, Field Mus. Nat. Hist., Zool. Ser., 7, p. 411, 1910.

11 (2351, 2364, 2378, 2383): Voi, Kenya Colony (Akeley, 1906).

1 (2356): Lukenya, Kenya Colony (Akeley, 1906).

2 (2368, 2370): Nairobi, Kenya Colony (Akeley, 1906).

9 (2380, 2390): Molo, Kenya Colony (Akeley, 1906).

1 (12276): Mnazi, Tanganyika Territory (Zimmer, 1926).

3 (12894, 12908, 12985): Kabengere, Belgian Congo (Zimmer, 1926).

1 (15087): Bisan River, Ethiopia (Albrecht, 1929).

Nine of the above specimens are embryos and have not been utilized for the following remarks.

Midbody scale-rows 30–34; dorsals tricarinate; frontoparietals paired; subocular largely borders the lip; ear-lobules short; the adpressed hind limb does not reach the axilla except in Numbers 2351 and 12276 from Voi and Mnazi respectively; scales on the soles spinose. Largest specimen (No. 12985) measures 137 (62+75) mm.

The skink from Guban, Somaliland Protectorate, referred to *varia* by Meek in his earlier paper, is in reality an example of *striata*.

Mabuya varia damaranus (Peters).

Euprepes damaranus Peters, Oefvers. Vet.-Akad. Förh., p. 660, 1869—Damaraland.

Mabuya varia var. *longiloba* Methuen and Hewitt, Ann. Transvaal Mus., 4, p. 142, 1914 (1913)—Namaqualand.

3 (16022–4): Kleinzee, Cape Province (Wecke, 1931).

Midbody scale-rows 32; subocular between the fourth and fifth or fifth and sixth labials. These specimens differ from typical *varia* in their uniformly long ear-lobules and their smaller size, for the largest specimen is a gravid female measuring 96 (43+53) mm. Size, however, is not a safe guide, to judge by the paratype of *longiloba* in the collection of the Museum of Comparative Zoology.

Placed with the Field Museum series of *M. v. varia* these Kleinzee skinks are immediately conspicuous by their darker coloring and absence of markings, but this character is an average one as occasional individuals without markings are found in East Africa and sometimes specimens with markings in Southwest Africa.

In 1928 (Barbour and Loveridge, 1928, Mem. Mus. Comp. Zool., p. 160) I was party to considering *longiloba* a synonym of *varia* as occasional individuals taken in desert areas of East Africa have much longer lobules than those from the grasslands. It would appear that the size of the lobules is a response to the need for protecting the ear-opening from drifting sand. I now consider that *longiloba* does represent a recognizable race in the southwest but that *damaranus* of Peters has precedence.

Mabuya striata (Peters).

Tropidolepisma striatum Peters, Monatsb. Akad. Wiss. Berlin, p. 36, 1844—Mozambique.

Mabuia striata Boulenger, Cat. Liz. Brit. Mus., 3, p. 204, 1887; Meek, Field Mus. Nat. Hist., Zool. Ser., 7, p. 411, 1910.

Mabuia varia Meek (not Peters), Field Mus. Nat. Hist., Zool. Ser., 1, p. 181, 1897.

1 (367): Durban, Guban, Somaliland Protectorate (Akeley, 1896).

2 (2352, 2357): Lukenya, Kenya Colony (Akeley, 1906).

5 (2367, 2371, 6564): Nairobi, Kenya Colony (Akeley, 1906).

3 (2428–9): Lake Elmenteita, Kenya Colony (Akeley, 1906).

5 (8990–4): Bambuni, Belgian Congo (Heller, 1925).

2 (12277–8): Mnazi, Tanganyika Territory (Zimmer, 1926).

1 (12304): Uleia, Tanganyika Territory (Zimmer, 1926).

1 (12322): Matameras, Tanganyika Territory (Zimmer, 1926).

3 (12330–1, 12335): Ulambo, Tanganyika Territory (Zimmer, 1926).

1 (12524): Awadi River, Ethiopia (Osgood, 1927).

2 (12807–8): Mambawanga Hill, Belgian Congo (Heller, 1925).

3 (12901, 12913, 12964): Kabengere, Belgian Congo (Zimmer, 1926).

Midbody scale-rows 32–40; prefrontals separated in all except No. 12330 where they are barely in contact. Largest specimen measures 88 mm. from snout to anus, tail missing.

Emoia breviceps (Peters).

Euprepis (Mabuia) breviceps Peters, Monatsb. Akad. Wiss. Berlin, p. 604, 1873 Gaboon (i.e. French Congo).

Lygosoma breviceps Boulenger, Cat. Liz. Brit. Mus., 3, p. 300, 1887.

Mabuia batesii Boulenger, Proc. Zool. Soc. Lond., p. 449, pl. xxi, fig. 2, 1900— Benito River, French Congo.

2 (3977-8): Kribi River, Cameroon (Bates).

Midbody scale-rows 32; unfortunately the Catalogue of Lizards gives these as 56-57 which in reality is the number of transverse ventral scale-rows; in specimen No. 3977 the prefrontals are fused into one shield excluding the internasal from contact with the frontal; in specimen No. 3978 the internasal and frontal are in contact. A topotype of *batesii* received from the British Museum is undoubtedly conspecific with our series of Cameroon *breviceps*. Larger specimen measures 123 (61+62) mm.

Riopa fernandi (Burton).

Tiliqua fernandi Burton, Proc. Zool. Soc. Lond., p. 62, 1836 Fernando Po.

Lygosoma fernandi Boulenger, Cat. Liz. Brit. Mus., 3, p. 304, 1887.

1 (12763): Beni, Belgian Congo (Heller, 1925).

Midbody scale-rows 36. Length from snout to anus 112 mm., tail missing.

Riopa sundevallii (Smith).

Eumeces (Riopa) sunderallii (sic) A. Smith, Illus. Zool. S. Africa, 3, App., p. 11, 1849—Natal.

Lygosoma sundevallii Boulenger, Cat. Liz. Brit. Mus., 3, p. 307, 1887; Meek, Field Mus. Nat. Hist., Zool. Ser., 7, p. 412, 1910.

1 (6565): Kijabe, Kenya Colony (Akeley, 1906).

2 (12301, 12308): Uleia, Tanganyika Territory (Zimmer, 1926).

Midbody scale-rows 24–26. Largest specimen measures 205 (115+90) mm.

Siaphos graueri graueri (Sternfeld).

Lygosoma graueri Sternfeld, Wiss. Ergebn. Deutsch-Zentral-Afrika-Exped., 4, p. 240, fig. 3, and *quinquedigitata*, p. 241, pl. vi, fig. 5, 1912—Karisimbi and vicinity, Belgian Ruanda-Urundi.

1 (9864): 8,500 ft., Sabinio Volcano, Uganda (Heller, 1925).

1 (9865): 8,300 ft., Bihunga Escarpment, Uganda (Heller, 1925).

Midbody scale-rows 22; fingers 5; toes 5; belly spotted. Larger specimen measures 64 mm. from snout to anus, tail missing.

After describing *graueri* Sternfeld remarks that it may be divided into two subspecies and gives a name to each; the first of these, *quinquedigitata*, must be regarded as synonymous with *graueri*.

Siaphos meleagris helleri Loveridge.

Siaphos meleagris helleri Loveridge, Proc. Biol. Soc. Wash., **45**, p. 113, 1932 - Bugongo Ridge, Ruwenzori, Belgian Congo.

1 (12749): Bugongo Ridge, Belgian Congo (Heller, 1925).

This is the type and only known specimen; by a stupid mistake I gave the Bugongo Ridge as being on the Uganda side of the Ruwenzori range though I had ascertained that it was on the western (Belgian Congo) side. It is the typical form that occurs on the Uganda slopes.

Ablepharus wahlbergii (Smith).

Cryptoblepharus wahlbergii A. Smith, Illus. Zool. S. Africa, **3**, App., p. 10, 1849— Natal.

Ablepharus wahlbergii Boulenger, Cat. Liz. Brit. Mus., **3**, p. 350, 1887; Meek, Field Mus. Nat. Hist., Zool. Ser., **7**, p. 412, 1910.

1 (2352): Lukenya, Kenya Colony (Akeley, 1906).

1 (2381): Voi, Kenya Colony (Akeley, 1906).

2 (2391): Nairobi, Kenya Colony (Akeley, 1906).

3 (12289, 12305, 12313): Uleia, Tanganyika Territory (Zimmer, 1926).

Midbody scale-rows 24-26, average 25. Largest specimen measures 51 mm. (not 46 as given by Meek) from snout to anus, tail missing.

Scincus scincus scincus (Linnaeus).

Lacerta stincus (sic) Linnaeus, Syst. Nat., **1**, p. 205, 1758 Libya; Egypt; Arabia petrae.

Scincus officinalis Boulenger, Cat. Liz. Brit. Mus., **3**, p. 391, 1887.

Scincus officinalis lineolata Werner, Sitzber. Akad. Wiss. Wien, **123**, p. 343, 1914— Egypt.

4 (607, 1869): Cairo, Egypt (Flower and British Museum).

Midbody scale-rows 26; supraoculars 6. Largest specimen measures 155 (104+51) mm.

Linnaeus' name *scincus* has precedence over *officinalis*, which has been more commonly employed. Werner's race *lineolata* is apparently indistinguishable from the typical form. Trinomials are, however, necessary on account of the other color races proposed by

him, both of which are represented in the Museum of Comparative Zoology.

Chalcides ocellatus ocellatus (Forskål).

Lacerta ocellata Forskål, Hist. Anim., p. 13, 1775 Egypt.

Chalcides ocellatus (part) Boulenger, Cat. Liz. Brit. Mus., 3, p. 400, 1887.

Lyogsoma (sic) *akeleyi* Meek, Field Mus. Nat. Hist., Zool. Ser., 1, p. 182, 1897 —Berbera, British Somaliland.

2 (366, 369): Berbera, British Somaliland (Akeley, 1896).

1 (606): Alexandria, Egypt (Flower).

Midbody scale-rows 28–30. Largest specimen measures 190 (94+96) mm. This is the paratype of *akeleyi* Meek which appears to be indistinguishable from the typical form of *ocellatus*, as already pointed out by Boulenger in 1898. It cannot be identified with either *C. o. ragazzii* Boulenger from Assab, Eritrea, or *C. o. humilis* Boulenger from Ghinda, Eritrea.

Chalcides ocellatus tiligugu (Gmelin).

(*Lacerta*) *tiligugu* Gmelin, in Linnaeus, Syst. Nat., 13th ed., 1, p. 1073, 1788 - Sardinia.

Chalcides ocellatus (part) Boulenger, Cat. Liz. Brit. Mus., 3, p. 400, 1887.

2 (588): Algiers, Algeria (British Museum).

2 (3969–70): El Kantara, Algeria (Buxton, 1913).

Midbody scale-rows 30–32. Largest specimen measures 216 (130+86) mm. The distribution of this color race in relation to that of the typical form is peculiar. About a dozen races have been described of which eight are in the collection of the Museum of Comparative Zoology.

Chalcides bottegi bottegi Boulenger.

Chalcides bottegi Boulenger, Ann. Mus. Civ. Nat. Stor. Genova, (2), 18, p. 719, pl. x, fig. 1, 1898 Sancurar and Amarr, Ethiopia.

Chalcides pulchellus Mocquard, Bull. Mus. Hist. Nat. Paris, p. 466, 1906 - Lobi District, French Sudan.

1 (1870): Zegi, Ethiopia (British Museum).

Midbody scale-rows 24. Total length 193 (101+92) mm. This specimen agrees closely with the description of *bottegi* and judging also from the description of *pulchellus* the latter only differs from *bottegi* in possessing spotting on the under side of the tail. In this respect it agrees with the western race listed below, though in possessing 24 midbody scale-rows its affinities seem close to the

typical form. Mocquard compared it with *ocellatus*, apparently having overlooked the description of *bottegi*, as well as that of *thierryi*, both of which have the two median rows of dorsal scales much enlarged.

Chalcides bottegi thierryi Tornier.

Chalcides bottegi var. *thierryi* Tornier, Arch. Naturg., p. 87, 1901—Mangu and Jendi, Togoland.

1 (16370): Marama, Nigeria (Heckman).

Midbody scale-rows 20. Total length 275 (130+145) mm. This example agrees very closely with Tornier's description which was based on two specimens each possessing 20 midbody scale-rows.

Chalcides delislii Boulenger.

Chalcides delislii Boulenger, Cat. Liz. Brit. Mus., 3, p. 407, 1887—? Senegambia.

1 (595): Suakin, Sudan (British Museum).

Midbody scale-rows 24; fore limbs tridactyl; hind limbs tetradactyl. Length from snout to anus 85 mm., tail missing.

Chalcides sepoides (Audouin).

Scincus sepoides Audouin, Descr. l'Egypte, Rept., Suppl., p. 180, pl. ii, figs. 9 and 10, 1829—Egypt.

Chalcides sepoides Boulenger, Cat. Liz. Brit. Mus., 3, p. 407, 1887.

2 (618): Giza, Egypt (British Museum).

Midbody scale-rows 24; all limbs pentadactyl. Larger specimen measures 133 (86+47) mm.

Scelotes bipes (Linnaeus).

Anguis bipes Linnaeus, Syst. Nat., 1, p. 227, 1758—"Indiis."

Scelotes bipes Boulenger, Cat. Liz. Brit. Mus., 3, p. 414, 1887.

2 (16025-6): Kleinzee, Cape Province (Wecke, 1931).

Midbody scale-rows 18; hind limbs didactyl. Larger specimen measures 147 (91+56) mm.

Feylinia currori currori Gray.

Feylinia currori Gray, Cat. Liz. Brit. Mus., p. 129, 1845—Angola; Boulenger, Cat. Liz. Brit. Mus., 3, p. 431, 1887.

1 (3991): Bitye, Cameroon (Bates).

Midbody scale-rows 22, also on neck and in front of anus; third labial in contact with eye. Total length 132 (95+37) mm.

Typhlosaurus meyeri Boettger.

Typhlosaurus meyeri Boettger, Abh. Mus. Dresden, No. 5 (no pagination), 1894 Angra Pequena, Southwest Africa.

5 (16027–30, 16034): Kleinzee, Cape Province (Wecke, 1931).

Midbody scale-rows 14; rostral about equal in length to the total length of all the other head-shields together. Largest specimen measures 131 (106+25) mm. The coloration of the series is of two types; three specimens have a broad, chocolate-colored, vertebral band, four scales in width from the parietals to the end of the tail where it tapers to two scales in width. In these examples the ventral aspect of the tail is dusky. The remaining two skinks are pink and white respectively without markings except for an ill-defined dusky streak from the nostril to the eye, the occipital spot and a trace of pigmentation on, or around, the tip of the tail.

Typhlosaurus vermis Boulenger.

Typhlosaurus vermis Boulenger, Cat. Liz. Brit. Mus., 3, p. 434, pl. xxxviii, fig. 4, 1887—Cape of Good Hope.

3 (16031–3): Kleinzee, Cape Province (Wecke, 1931).

Midbody scale-rows 12; rostral about equal in length to twice the total length of all the other head-shields together. Largest specimen measures 239 (201+38) mm.

CHAMAELEONTIDAE

Chamaeleon chamaeleon (Linnaeus).

Lacerta chamaeleon Linnaeus (part), Syst. Nat., 1, p. 204, 1758—Africa.

Chamaeleon vulgaris Boulenger, Cat. Liz. Brit. Mus., 3, p. 443, 1887.

3 (594): Wadi Halfa, Sudan (British Museum).

1 (1583): North Africa (Basel Museum).

Chamaeleon basiliscus Cope.

Chamaeleo basiliscus Cope, Proc. Acad. Nat. Sci. Phila., p. 316, 1868—Korusko, Nubia, Sudan.

Chamaeleon basiliscus Boulenger, Cat. Liz. Brit. Mus., 3, p. 466, 1887.

1 (12727): Devark, Ethiopia (Osgood, 1927).

Chamaeleon senegalensis Daudin.

Chamaeleo senegalensis Daudin, Hist. Nat. Gen. Rept., 4, p. 203, 1802 region watered by the Senegal and Niger rivers; Gambia and Guinea.

Chamaeleon laevigatus Gray, Proc. Zool. Soc. Lond., p. 95, 1863—500 miles south of Khartum, Sudan.

Chamaeleon senegalensis Boulenger, Cat. Liz. Brit. Mus., 3, p. 448, 1887.

1 (13122): Northern Province, Uganda (Zimmer, 1927).

Chamaeleon gracilis gracilis Hallowell.

Chamaeleo gracilis Hallowell, Journ. Acad. Nat. Sci. Phila., p. 324, pl. xviii, 1842—Monrovia, Liberia.

Chamaeleon gracilis Boulenger, Cat. Liz. Brit. Mus., 3, p. 448, 1887.

1 (3965): Belgian Congo (Rosenberg).

Owing to the immaturity of this specimen it is impossible to decide whether it should belong to the typical race or to *etiennei* Schmidt.

Chamaeleon dilepis dilepis Leach.

Chamaeleo dilepis Leach, in Bowdich, Miss. Ashantee, App. p. 493, 1819—Gaboon.

Chamaeleon dilepis Boulenger, Cat. Liz. Brit. Mus., 3, p. 450, 1887.

3 (12323, 12336, 12342): Tanganyika Territory (Zimmer, 1926).

1 (12857): Katobwe, Belgian Congo (Zimmer, 1926).

6 (12906, 12965, 12970, 12979, 12984, 12989): Kabengere, Belgian Congo (Zimmer, 1926).

1 (13123): Katungulu, Mwanzi, Uganda (Zimmer, 1927).

5 (15365-9): Cuma, Angola (Hambly, 1929).

1 (15461): Caconda, Angola (Hambly, 1929).

All of the Angolan specimens with the exception of Number 15365, which is typical *dilepis*, might well be referred to *C. d. quilensis* Bocage but Numbers 12323 and 12857 have also the small lobes of *quilensis* and it is Dr. H. Hechenbleikner's opinion that the occurrence of chameleons of the *quilensis* type is so erratic that it hardly merits recognition as a geographic race.

Chamaeleon dilepis roperi Boulenger.

Chamaeleon roperi Boulenger, Proc. Zool. Soc. Lond., p. 85, pl. viii, fig. 4, 1890—Kilifi, north of Mombasa, Kenya Colony.

Chamaeleon dilepis Meek (not of Leach), Field Mus. Nat. Hist., Zool. Ser., 7, p. 414, 1910.

2 (2295, 6449): Machakos, Kenya Colony (Akeley, 1906).

1 (2388): Voi, Kenya Colony (Akeley, 1906).

1 (15075): Bisan River, Ethiopia (Albrecht, 1929).

Chamaeleon bitaeniatus bitaeniatus Fischer.

Chamaeleo bitaeniatus Fischer, Jahrb. Hamb. Wiss. Anst., 1, p. 23, pl. ii, fig. 7, 1884—Lake Naivasha, Kenya Colony.

Chamaeleon bitaeniatus Boulenger, Cat. Liz. Brit. Mus., 3, p. 452, 1887.

Chamaeleon ellioti Meek (not of Günther), Field Mus. Nat. Hist., Zool. Ser., 7, p. 414, 1910.

10 (2254, 2282–3, 2287, 2290–1, 2294, 2297): Lukenya, Kenya Colony (Akeley, 1906).

2 (2285–6): Kijabe, Kenya Colony (Akeley, 1906).

4 (9866–9): Kigezi District, Uganda (Heller, 1925).

9 (9870–1, 9873, 9875–6, 9878, 9880–2): Kisolo, Uganda (Heller, 1925).

1 (12762): Beni, Belgian Congo (Heller, 1925).

1 (12832): Ruchuru, Belgian Congo (Heller, 1925).

The Uganda and Belgian Congo specimens are referred to the typical race with some doubt. They agree with the typical form in the elevation of the casque as compared with the length of the mouth; in size, however, they are larger than typical *bitaeniatus* of the East African highlands. This may be a result of the more tropical conditions under which they live or they may be regarded as intermediates between the typical form and *ellioti*.

Chamaeleon bitaeniatus ellioti Günther.

Chamaeleon ellioti Günther, Ann. Mag. Nat. Hist., (6), **15**, p. 524, pl. xxi, fig. A, 1895—foot of Mount Ruwenzori, Uganda.

2 (1844): Mount Ruwenzori, Uganda (British Museum).

1 (6979): Lake Kivu, Belgian Ruanda-Urundi (Heller, 1924).

1 (12782): Kisenji, Belgian Ruanda-Urundi (Heller, 1924).

1 (12806): Mambawanga Hill, Belgian Congo (Heller, 1925).

The Lukenya specimens referred to *ellioti* by Meek are typical *bitaeniatus* as recorded above.

Chamaeleon bitaeniatus rudis Boulenger.

Chamaeleon rudis Boulenger, Ann. Mag. Nat. Hist., (7), **18**, p. 473, 1906—Mount Ruwenzori, Uganda.

4 (9872, 9874, 9877, 9879): Kisolo, Uganda (Heller, 1926).

Chamaeleon bitaeniatus höhnelii Steindachner.

Chamaeleon höhnelii Steindachner, Sitzber. Akad. Wiss. Wien, **100**, p. 307, pl. i, fig. 1, 1891—Leikipia, Kenya Colony.

Chamaeleon hoehneli (sic) Meek, Field Mus. Nat. Hist., Zool. Ser., **7**, p. 413, 1910.

Chamaeleon bitaeniatus höhnelii Loveridge, Bull. U. S. Nat. Mus., **151**, p. 87, 1929.

1 (1845): Lagari, Kenya Colony (Betton).

2 (2281): Kijabe, Kenya Colony (Akeley, 1906).

4 (2288 9, 2292–3): Lukenya, Kenya Colony (Akeley, 1906).

Young+7 (2295, 6423, 6425–9): Molo, Kenya Colony (Akeley, 1906).

2 (2299, 2304): Mount Kenya, Kenya Colony (Akeley, 1906).

3 (2307–8, 2389): Voi, Kenya Colony (Akeley, 1906).

Chamaeleon pumilus Daudin.

Chamaeleo pumilus Daudin, Hist. Nat. Gen. Rept., **4**, p. 212, pl. liii, 1801—Cape of Good Hope.

Chameleon pumilus Boulenger, Cat. Liz. Brit. Mus., **3**, p. 458, 1887.

2 (1846): Port Elizabeth, Cape Province (British Museum).

1 (16002): Port Nolloth, Cape Province (Wecke, 1931).

Chamaeleon affinis Gray.

Chamaeleon affinis Gray, Proc. Zool. Soc. Lond., p. 95, 1863 Abyssinia (Ethiopia).

Chamaeleon affinis Boulenger, Cat. Liz. Brit. Mus., **3**, p. 461, pl. xxxix, fig. 7, 1887.

1 (12726): Devark, Ethiopia (Osgood, 1927).

Chamaeleon namaquensis Smith.

Chamaeleo namaquensis Smith, S. Africa Quarterly Journ., No. 5, p. 17, 1831 near mouth of Orange River, Little Namaqualand.

Chamaeleon namaquensis Boulenger, Cat. Liz. Brit. Mus., **3**, p. 462, 1887.

1 (16001): Port Nolloth, Cape Province (Wecke, 1931).

Chamaeleon cristatus Stutchbury.

Chamaeleo cristatus Stutchbury, Trans. Linn. Soc. Lond., **17**, p. 361, pl. x, 1837—Gaboon.

Chameleon cristatus Boulenger, Cat. Liz. Brit. Mus., **3**, p. 471, 1887.

1 (17040): Batanga, Cameroon (University of Chicago, 1903).

Total length 212 (117+95) mm.

Chamaeleon jacksoni Boulenger.

Chamaeleon jacksoni Boulenger, Ann. Mag. Nat. Hist., (6), **17**, p. 376, 1896 Uganda (in error); Meek, Field Mus. Nat. Hist., Zool. Ser., **7**, p. 413, 1910.

Chamaeleon jacksoni var. *vauerescecae* Tornier, Zool. Jahrb. Syst., **19**, p. 176, 1903—forest at 7,000 feet at Nairobi, Kenya Colony.

Chamaeleon jacksoni vauerescecae Loveridge, Bull. U. S. Nat. Mus., **151**, p. 90, 1929.

11 (2279, 2298, 2300, 2302 3, 2305 6): Lukenya Province, Kenya Colony (Akeley, 1906).

As no other records of *jacksoni* had been recorded since the type, I suggested to Mr. H. W. Parker that Boulenger had given "Uganda" in its old vague sense, which extended to include Lake Naivasha. Mr. Parker replied that Uganda had been struck out in the register and British East Africa substituted in Mr. Boulenger's handwriting. As a result *vauerescecae* of Tornier must become a synonym, being almost topotypic of *jacksoni*.

Chamaeleon johnstoni Boulenger.

Chamaeleon johnstoni Boulenger, Proc. Zool. Soc. Lond., p. 136, pl. xiii, 1901—Mubuku Valley, Ruwenzori, Uganda.

1 (1843): Ruwenzori Mountains at 6,000 feet (British Museum).

5 (6982–6): Lake Kivu, Belgian Ruanda-Urundi (Heller, 1924).

6 (12783–8): Kisenji, Belgian Ruanda-Urundi (Heller, 1924).

This species is now known to be extremely variable and the races such as *graueri* cannot be recognized. In the above series for example there are a few individuals with enlarged conical plates on the sides but in the majority the sides are granular without strikingly enlarged plates.

Rhampholeon kerstenii robecchii Boulenger.

Rhampholeon robecchii Boulenger, Ann. Mus. Civ. Stor. Nat. Genova, (2), 12, p. 13, pl. i, fig. 3, 1892 Wuorandi, near Obbia, Italian Somaliland.

Rhampholeon mandera Meek, Field Mus., Zool. Ser., 1, p. 183, 1897 Mandera, British Somaliland.

1 (370): Mandera, British Somaliland (Akeley, 1896).

Meek's type is undoubtedly synonymous with Boulenger's *robecchii* which Parker has recently made a race of *kerstenii*.

Rhampholeon spectrum (Buchholz).

Chamaeleo spectrum Buchholz, Monatsb. Akad. Wiss. Berlin, p. 298, pl., figs. 5 and 6, 1874—Cameroon.

Rhampholeon spectrum Boulenger, Cat. Liz. Brit. Mus., 3, p. 476, 1887.

1(1848): Benito River, Spanish Guinea (British Museum).

PIPIDAE

Xenopus laevis victorianus Ahl.

Xenopus victorianus Ahl, Zool. Anz. Leipzig, 60, p. 270, 1924—Bussisi, i.e. Busisi, Lake Victoria, Tanganyika Territory.

Xenopus laevis victorianus Loveridge, Bull. Mus. Comp. Zool., 74, p. 351, 1933.

14 (12020–33): Bihunga Escarpment, Uganda (Heller, 1925).

These frogs, taken at 8,300 feet, have been compared with the material listed in the second citation and from which they appear to be indistinguishable though averaging smaller. In this respect they are intermediate between *victorianus* and *bunyoniensis*. They may be distinguished from the latter by their more acuminate snouts, the sides of their heads not being parallel, and, in the adults, the width of their bodies is greater than that of their heads, though this is not the case in the young which approximate to *bunyoniensis* in this respect. The lower surface is more or less immaculate in nine frogs, slightly mottled or marbled in five. The largest example (No. 12023) is a female greatly bloated with ova, taken December 2, 1925, and measuring 52 mm.

Xenopus laevis bunyoniensis Loveridge.

Xenopus laevis bunyoniensis Loveridge, Proc. Biol. Soc. Wash., **45**, p. 114, 1932—Lake Bunyoni, Kigezi District, Uganda.

99 (12177–12181): Lake Bunyoni, Uganda (Heller, 1925).

The above series are paratypes of this race and were fully discussed in the citation given. A key to the races is provided in the 1933 paper mentioned under *X. l. victorianus*.

BUFONIDAE

Bufo regularis regularis Reuss.

Bufo regularis Reuss, Mus. Senckenberg, **1**, p. 60, 1834—Egypt; Boulenger, Cat. Batr. Sal. Brit. Mus., p. 298, 1882; Meek, Field Mus. Nat. Hist., Zool. Ser., **7**, p. 404, 1910.

Bufo garmani Meek, Field Mus., Zool. Ser., **1**, p. 176, 1897—Halleh, British Somaliland.

2 (415–6): Halleh, British Somaliland (Akeley, 1896).

2 (2307, 2396): Athi Plains, Kenya Colony (Akeley, 1906).

1 (2416): Molo, Kenya Colony (Akeley, 1906).

1 (2417): Lukenya Hills, Kenya Colony (Akeley, 1906).

2 (2426–7): Lake Elmenteita, Kenya Colony (Akeley, 1906).

1 (12325): Matameras, Tanganyika Territory (Zimmer, 1926).

1 (12518): Ethiopia (Bailey, 1926).

1 (12520): Lake Shala, Arusi, Ethiopia (Osgood, 1927).

1 (12521): Mount Albasso, Ethiopia (Osgood, 1926).

2 (12530–1): Sheik Hussein, Bale, Ethiopia (Osgood, 1926).

5 (12701–5): 25 miles west of Lake Tana, Ethiopia (Osgood, 1927).

10 (12714–23): Addis Ababa, Ethiopia (Osgood, 1927).

1 (12725): Metemma, Ethiopia (Osgood, 1927).

3 (12798, 12800, 12803): Mambawanga Hill, Belgian Congo (Heller, 1925).

2 (12834–5): Ruchuru, Belgian Congo (Heller, 1925).

4 (12898–900, 12911): Kabengere, Luapula, Belgian Congo (Zimmer, 1926).

2 (13119–20): White Nile District, Uganda (Zimmer, 1926).

1 (15088): South of Bisan River, Ethiopia (Albrecht, 1929).

4 (15361–4): Cuma, Angola (Hambly, 1929).

These 46 toads agree in possessing a tarsal fold and all the key characters employed by Noble (1924, Bull. Amer. Mus. Nat. Hist., **49**, pp. 167–168). In connection with the identification of this material, I have endeavored to ascertain what races of *regularis* may be recognized. Unfortunately there is very little topotypic material of the nominate form available and I have had to assume that East African toads are of the typical race. Sexing is based on the brown nuptial pad present on the first finger of the male. The head in males is usually more acuminate than in females.

B. r. regularis Reuss, 1834, *Egypt.* A topotypic female of 66 mm. and three young of 27–35 mm. give the following results: End of snout steep when viewed laterally; transverse diameter of tympanum one-half to two-thirds the orbital diameter; width of parotid 2 to 2¼ times its length; fingers moderate, their tips blunt; tibio-tarsal articulation of adpressed hind limb reaches axilla (in 2) or shoulder (in 2); tibia 2.4 to 2.8 times in length from snout to anus.

B. r. maculatus Hallowell 1854 being n.n. for *cinereus* Hallowell, 1844, preoccupied. *Liberia.* Eight males (45–56 mm.), ten females (48–75 mm.), and eight topotypic young (21–36 mm.) give the following results: End of snout steep when viewed laterally; transverse diameter of tympanum one-half to three-fourths times the orbital diameter; width of parotid two to three times in its length; fingers slender, tapering; the tibio-tarsal articulation of the adpressed hind limb reaches the axilla (in 10) or shoulder (in 16); tibia 2.2 to 2.6 times in the length from snout to anus. On comparing a topotype female *maculatus* with the topotype female *regularis* they were found to agree in dorsal tubercles, large tubercles on forearm, size of metatarsal tubercles, webbing of toes, etc., but could be separated on the rather more slender, certainly more tapering toes of *maculatus*.

Bufo garmani Meek, 1897, *Halleh, British Somaliland.* Both types juveniles, one at least an immature female. Despite their dried condition all the key characters of typical *regularis* may be detected.

With no other Somaliland material I examined the Ethiopian specimens listed above. These consisted of nine males (64–82 mm.), eleven females (55–96 mm.), and two young (35–40 mm.), which gave the following results: End of snout steep when viewed laterally; transverse diameter of tympanum one-half to two-thirds times the orbital diameter; width of parotid two to three times in its length; fingers thick, their tips blunt; the tibio-tarsal articulation of the adpressed hind limb reaches the axilla (in 13) or shoulder (in 2) far short of axilla (in No. 15088), the rest being too dried to ascertain; tibia 2.2 to 2.6 times in the length from snout to anus in both sexes.

The largest female (No. 12720) measures 98 mm., but this Ethiopian toad is only 8 mm. longer than specimens from Molo, Kenya Colony (No. 2416), and Cuma, Angola (No. 15363); the smallest toad in the series (No. 2307) only measures 12 mm. I conclude that there are no grounds on which Ethiopian frogs can be distinguished from the typical form, not even size, for Anderson records a male from Egypt as being 91 mm.

Bufo spinosus Bocage, 1867, *Benguela, Angola.* Preoccupied by *spinosus* Daudin, 1803. I failed to find any difference between the Angolan and Ethiopian frogs. Spinosity is a secondary sexual character of the breeding male and evidently many of the Ethiopian series were collected when the males had assembled at the pools at Addis Ababa, for at first glance their strongly spinose backs (where small spines are arranged in rosettes upon the greatly swollen tubercles) give them a very distinctive appearance. When, however, one of these males is compared with a breeding male which I took *in coitu* in Tanganyika Territory, the distinction is less apparent and the slight differences between toads from these two countries could hardly be stated in words.

Bufo tuberculosus Bocage, 1896, *Linokana, Bechuanaland*, is preoccupied by *tuberculosus* Risso, 1826. However, *B. regularis gutteralis* Power, 1927, *Lobatsi, Bechuanaland*, appears to represent the same toad and Power has recorded *gutteralis* from Linokana. Now that he has found the slender-fingered *gutteralis* occurring in the same ponds or localities with the thicker-fingered *regularis* and breeding at the same time, either they must be specifically distinct or racially identical! Slender and stubby-fingered individuals occur in the same human family, so perhaps we shall find that this variability occurs within the limits of a species among toads. Though the Museum of Comparative Zoology possesses a paratype of *gutteralis* I hesitate to form a definite opinion as to its status.

Bufo lemairii Boulenger, 1901, was described from Pweto, Lake Mweru, Belgian Congo, and one would naturally expect Zimmer's specimens from Kabengere on the Luapula River, which flows out of Lake Mweru, to represent the same toad. I am indebted to Dr. Gaston de Witte for the opportunity to examine a pair of *Bufo lemairii*, a long-toed species with acuminate snout. I suggested to Dr. de Witte that Boulenger's holotype, said to be a female, was in reality a male. He confirms this opinion; nevertheless the female of this species has a more acuminate snout than the male.

Since the foregoing was written (1932) several other descriptions of races of *regularis* have appeared.

Bufo regularis kisoloensis Loveridge.

Bufo regularis kisoloensis Loveridge, Proc. Biol. Soc. Wash., **45**, p. 52, 1932—Kisolo, Kigezi District, Uganda.

43 (9885–9, 12005): Kisolo, Kigezi, Uganda (Heller, 1926).

10 (12006–15): Bihunga Escarpment, Uganda (Heller, 1926).

10 (12124–30, 12132–34): Sabinio Volcano, Uganda (Heller, 1926).

13 (12164–76): Lake Bunyoni, Kigezi, Uganda (Heller, 1925).

The Kisolo specimens constitute the type and paratypes of this race which is distinguished from all other forms of *regularis* by having the toes, except the fourth, webbed to their tips, occasionally only almost to their tips.

The Bihunga, Sabinio and Bunyoni toads are rather less webbed and may be regarded as intermediates between *kisoloensis* and *regularis* but approaching the former. The data of the Bihunga and Sabinio specimens were collected. Twelve males (50–65 mm.), one female (53 mm.), and eight young (24–40 mm.) give the following results: End of snout sloping when viewed laterally; transverse diameter of tympanum one-half (in the smallest only) to two-thirds or three-fourths times the orbital diameter in adults; width of parotid two to three times in its length; fingers slender, pointed; the tibio-tarsal articulation of the adpressed hind limb reaches to the axilla (in 4) or shoulder (in 16); tibia 2.2 to 2.5 times in the length from snout to anus. One male (No. 12009) differs from the rest in the heavily mottled under parts.

Bufo camerunensis camerunensis Parker.

Bufo camerunensis camerunensis Parker, Proc. Zool. Soc. Lond., p. 153, 1936—Oban, Calabar, Nigeria.

1 (3577): Abanga River, French Congo (Bates).

2 (3578, 3580): Bitye, Cameroon (Bates).

1 (12769): Mambawanga Hill, Belgian Congo (Heller, 1925).

Parker (l.c. supra) has recently shown that *polycerus* Werner is a synonym of *tuberosus* Günther and what has been universally regarded as *polycerus* is, in reality, an undescribed species for which he proposes the name *camerunensis*.

Superficially like *regularis* but differing in their strongly developed, rather spinose, temporal tubercles. I have considered the possibility of others in the Mambawanga Hill series being young of *camerunensis* for they are certainly somewhat intermediate as their temporal tubercles are more developed than is usual with *regularis*. The above series agree in possessing a well-developed tarsal fold and in having the fifth (outer) toe webbed to a point slightly in advance of the penultimate subarticular tubercle.

The largest of three females measures 75 mm., the smallest toad 16 mm.; both are from Bitye.

Bufo funereus Bocage.

Bufo funereus Bocage, Jorn. Sci. Lisboa, **1**, p. 77, 1866—Duque de Bragança; Boulenger, Cat. Batr. Sal. Brit. Mus., pp. 281 and 475, 1882.

1 (19892): Bitye, Cameroon (Bates).

3 (12227–9): Bambuni, Belgian Congo (Heller, 1925).

7 (12795, 12797, 12799, 12801–2, 12804–5): Mambawanga Hill, Belgian Congo (Heller, 1925).

Superficially like *regularis* but differing in the complete absence of a tarsal fold though its position may be indicated by a series of enlarged tubercles as in No. 12799; the outer (fifth) toe is webbed to the tip (six specimens) or almost to the tip (four specimens); the first finger is usually only slightly longer than the second, though occasionally it may be much longer (e.g. Nos. 12795, 12805). I find that this character fails to distinguish *funereus* from *tuberosus* which, however, may be known by its prominent ovate parotid, this gland being elongate in *funereus*.

The largest of ten females measures 61 mm.

Bufo tuberosus Günther.

Bufo tuberosus Günther, Cat. Batr. Sal. Brit. Mus., p. 60, pl. iii, fig. C, 1858—Fernando Po; Boulenger, Cat. Batr. Sal. Brit. Mus., p. 304, 1882.

Bufo polycerus Werner, Sitzber. Akad. Wiss., München, **27**, p. 211, 1897—Cameroon.

2 (3585–6): Efulen, Cameroon (Bates).

The larger of these toads is a male measuring 41 mm.

Bufo gariepensis gariepensis Smith.

Bufo gariepensis Smith, Illus. Zool. S. Africa, 3, pl. lxix, figs. 2 and 2a, 1849—Banks of the Orange River, Cape Colony.

1 (15548): Lady Frere, Cape Province (Romer, 1929).

This specimen has been compared with cotypes of *Bufo granti* Boulenger and other examples of *gariepensis* in the collection of the Museum of Comparative Zoology. The tarso-metatarsal articulation of the adpressed hind limb reaches the tympanum in four of these and falls short in one; the tibio-tarsal articulation reaches the axilla in three and falls short in two, apparently irrespective of sex.

The Lady Frere female measures 73 mm.

Bufo superciliaris Boulenger.

Bufo superciliaris Boulenger, Proc. Zool. Soc. Lond., p. 565, 1887—Rio del Rey, Cameroon.

1 (12794): Mambawanga Hill, Belgian Congo (Heller, 1925).

This female measures 85 mm.

Bufo carens Smith.

Bufo carens Smith, Illus. Zool. S. Africa, 3, pl. xlviii, fig. 1, 1849—"Interior of South Africa"; Boulenger, Cat. Batr. Sal. Brit. Mus., p. 301 (part), 1882.

1 (10880): Bechuanaland (Basel Museum).

This female measures 70 mm.

Bufo blanfordii Boulenger.

Bufo blanfordii Boulenger, Cat. Batr. Sal. Brit. Mus., p. 301, pl. xix, fig. 4, 1882—Ain Sambar and Sooroo, Ethiopia.

Bufo viridis somalacus Meek, Field Mus., Zool. Ser., 1, p. 177, 1897—Halleh, British Somaliland.

6 (419–424): Halleh, British Somaliland (Akeley, 1896).

These toads, representing the type series of *somalacus* Meek, long considered a synonym of *blanfordii*, have now been compared with an example of *blanfordii* (M.C.Z. 15423) from Somaliland which was identified as such by Dr. G. A. Boulenger. These specimens have been adequately described by Meek who gives the measurements of each in inches. The type (No. 419), a juvenile male, is the largest of the series and measures 39 mm.

Bufo osgoodi Loveridge.

Bufo osgoodi Loveridge, Proc. Biol. Soc. Wash., 45, p. 47, 1932—Ethiopia.

1 (12529): Ethiopia (Osgood, 1926–27).

This is the female holotype of a recently described toad with hidden tympanum related to *Bufo lönnbergi* Andersson.

Nectophryne afra Buchholz and Peters.

Nectophryne afra Buchholz and Peters, Monatsber. Akad. Wiss. Berlin, p. 202, pl. ii, fig. 5, 1875 Cameroon; Boulenger, Cat. Batr. Sal. Brit. Mus., p. 279, 1882.

2 (3575–6): Bitye, Cameroon (Bates).

Though Bitye is the type locality of the closely related *N. batesii*, Boulenger, when describing the latter, figured both species from Bitye; this illustration makes it easy to distinguish them. The larger toad is gravid with a mass of ova and measures 22 mm.

RANIDAE

Scotobleps gabonicus Boulenger.

Scotobleps gabonicus Boulenger, Proc. Zool. Soc. Lond., p. 439, pl. xxviii, fig. 1, 1900—Benito River, French Congo; Parker, Proc. Zool. Soc. Lond., p. 141, 1936.

Astylosternus oxyrhynchus Nieden, Zool. Anz., 32, p. 660, 1908—Lolodorf, Cameroon.

Astylosternus gabonicus Parker, Ann. Mag. Nat. Hist., (10), 7, pp. 493–495, 1931.

2 (3626–7): Efulen, Cameroon (Bates).

Interorbital space half as wide as an upper eyelid; tympanum half the orbital diameter; toes webbed to the base of the terminal phalanx on the third and fifth toes, to the second phalanx on the fourth toe. The larger frog measures 51 mm.

Parker (1936) no longer considers *Scotobleps* synonymous with *Astylosternus*. These specimens, identified as *gabonicus* by Boulenger, do not differ in any important detail from *oxyrhynchus* which Nieden correctly referred to the genus *Astylosternus*. Of *oxyrhynchus* it is stated that the interorbital space is only a third the width of an upper eyelid but this is a character which is subject to variation depending largely on muscular contraction at the time of death.

Scotobleps camerunensis Ahl from Bipindi, Cameroon, may possibly be found to be synonymous also. Its chief claim to distinction lies in the length of the tibia which the author affirms is contained from two and a quarter to two and a third times in the length from snout to anus, in *gabonicus* about one and three-quarter times. This difference is reflected when the tibio-tarsal articulation of the adpressed hind limb marks the middle of the eye in *camerunensis*,

the nostril, or between the eye and the nostril, in *gabonicus* from the Cameroon and Gaboon.

Trichobatrachus robustus Boulenger.

Trichobatrachus robustus Boulenger, Proc. Zool. Soc. Lond., p. 443, pl. xxx, 1900 Benito River, Spanish Guinea; Parker, Ann. Mag. Nat. Hist., (10), 7, pp. 493–495, 1931; Parker, Proc. Zool. Soc. Lond., p. 141, 1936.

1 (14825): Lolodorf, Cameroon (Cozzens, 1928).

2 (15976–7): Cameroon (Cozzens, 1928).

The interorbital space is equal to an upper eyelid in the two males, once and a half times as wide in the female; in a score of Cameroon specimens in the Museum of Comparative Zoology an even greater range is shown in males, being from half the width (M.C.Z. 3383, 8821) to much broader (M.C.Z. 2612); the tympanum, sometimes barely distinguishable, agrees with the type in being half the diameter of the eye and I cannot but think it was accidental for Parker (1931)[1] to place *robustus* in his group (1) in which the tympanum is two-thirds the eye diameter; the horizontal diameter is always half, or less than half, the vertical is occasionally two-thirds. Nor has *robustus* a rudiment of web like the members of group (1); in the twenty-three specimens before me it is webbed like *gabonicus*, i.e. to the base of the terminal phalanx on the third and fifth toes, to the second phalanx on the fourth toe. An extraordinary variation in the size of the tongue is to be noted in the male specimens in Field Museum, showing how little value should be placed on this character. The variation is as follows:

The 130 mm. male has a tongue 19 mm. long and 21 mm. broad.

The 114 mm. male has a tongue 26 mm. long and 27 mm. broad.

The 115 mm. male (M.C.Z. 3373) has a tongue 25 mm. long and 19 mm. broad.

The larger male measures 130 mm., the female 98 mm.; none of the long series in the Museum of Comparative Zoology surpasses these measurements.

Astylosternus diadematus Werner.

Astylosternus diadematus Werner, Verh. Zool.-Bot. Ges. Wien, 48, p. 200, figs., 1898—Victoria, Cameroon; Parker, Ann. Mag. Nat. Hist., (10), 7, pp. 493–495, 1931.

Gampsosteonyx batesii Boulenger, Proc. Zool. Soc. Lond., p. 442, pl. xxix, 1900—Benito River, Spanish Guinea.

2 (3630–1): Efulen, Cameroon (Bates).

[1] Mr. Parker has since informed me that it was a slip.

The interorbital space equals an upper eyelid; tympanum two-thirds the orbital diameter; toes webbed at base only. The larger frog measures 52 mm.

Parker (1931), after amending the original description, remarks of the type of *Gampsosteonyx* that on osteological grounds it is generically indistinguishable from *Astylosternus* and adds, in a footnote, that probably *diadematus* and *batesii* are conspecific.

After a careful perusal of the two descriptions, I find that the only characters which apparently conflict are as follows:

diadematus	*batesii*
Tongue deeply emarginate	Tongue feebly notched behind
Outer metatarsals separated	Outer metatarsals bound together

The first of these, as shown by all the material at my disposal, is variable, dependent on the state of preservation, and Werner remarks that his single specimen was poorly preserved. If the second meant separated by web, a phrase often employed, the last apparent reason for keeping the two as distinct species is removed. In view of the closeness of markings and other characters as shown by the figures of the types I have no hesitation in considering *batesii* a synonym of *diadematus*.

Since the foregoing was written Parker (1936, Proc. Zool. Soc. Lond., p. 142) has synonymized *batesii* and *Dilobates platycephalus* Boulenger with *diadematus*.

Rana goliath Boulenger.

Rana goliath Boulenger, Ann. Mag. Nat. Hist., (7), **17**, p. 317, 1906—Efulen, Cameroon.

3 (14822–4): Lolodorf, Cameroon (Cozzens, 1928).

2 (15978–9): Cameroon (Cozzens, 1928).

It has been proposed to separate *goliath* from other members of the genus *Rana* under the name of *Gigantorana* (fide Noble, Biology of the Amphibia, p. 519, 1931), characterized by epicoracoids which are only weakly calcified. In March, 1931, Scortecci (Atti. Soc. ital. Milano, **20**, p. 17), separated *beccari*, *crassipes*, *goliath*, and *perpalmata* under the name of *Paleorana*. Any grouping which would separate *goliath* from *crassipes* would seem to be unnatural and unjustifiable. See Parker (1936, Proc. Zool. Soc. Lond., p. 137) for a more recent discussion of the position.

The tibio-tarsal articulation of the adpressed hind limb reaches the end of the snout in all except the largest frog (No. 14823) where it only reaches the eye, in this respect approaching *crassipes* where it

reaches from the tympanum to the eye. So closely allied are these two species that one wonders if juvenile *goliath* may not be sometimes misidentified as *crassipes;* the latter, however, breeds at a length of 65 mm.

The largest specimen measures 207 mm.

Rana crassipes Buchholz and Peters.

Rana crassipes Buchholz and Peters, Monatsber. Akad. Wiss. Berlin, p. 201, 1875 - Abo, Cameroon.

2 (3589–90): Efulen, Cameroon (Bates).

The larger frog measures 45 mm.

Rana subsigillata Duméril.

Rana subsigillata Duméril, Rev. Mag. Zool., p. 560, 1856—Gaboon; Boulenger, Cat. Batr. Sal. Brit. Mus., p. 23, 1882.

1 (3591): Ja River, Cameroon (Bates).

1 (3592): Abanga River, Gaboon (Bates).

Both are very young examples but display the vermiculations on the lower surface. They have three, not two, horny prominences on the front of the lower jaw.

The larger frog measures 30 mm.

Rana occipitalis Günther.

Rana occipitalis Günther, Cat. Batr. Sal. Brit. Mus., p. 130, pl. xi, 1858 "West Africa," "Africa," Gambia; Boulenger, Cat. Batr. Sal. Brit. Mus., p. 27, 1882.

1 (3594): Agberi, southern Nigeria.

A young male measuring 87 mm. A tadpole also bears the same registration number but I have not attempted to identify it.

Rana delalandii delalandii (Duméril and Bibron).

Pyxicephalus delalandii Duméril and Bibron, Erpét. Gén., 8, p. 445, pl. lxxxvii, figs. 1, 1a, and 1b, 1841—South Africa.

Rana delalandii Boulenger, Cat. Batr. Sal. Brit. Mus., p. 31, 1882.

"*Rana delandi* (Günther)" (sic) Meek, Field Mus., Zool Ser., 1, p. 175, 1897.

Rana (Tomopterna) hieroglyphica Ahl, Sitzber. Ges. naturf. Freunde Berlin, p. 42, 1927 (1925)—So-Omadu, Somaliland.

Rana (Pyxicephalus) delalandii Parker, Proc. Zool. Soc. Lond., p. 365, 1932.

1 (414): Hullieh, British Somaliland (Akeley, 1896).

1 (12534): Sheik Hussein, Ethiopia (Osgood, 1926).

2 (15089–90): South of Bisan River, Ethiopia (Albrecht, 1929).

Parker (Proc. Zool. Soc. Lond., p. 365, 1932) with sixty Somali specimens relegates *hieroglyphica* Ahl to the synonymy; an action which I endorse after examination of a paratype of *hieroglyphica* (M.C.Z. 17539).

The tibio-tarsal articulation of the adpressed hind limb reaches the eye in three of the above specimens, and to the shoulder only in an adult female (No. 12534) which is bloated with ova. This female is the largest frog and measures 47 mm. from tip of snout to vent.

One of the specimens from the Great Karas Mountains, Namaqualand, referred to *delalandii* by Methuen and Hewitt (Ann. Transvaal Mus., **4**, p. 124, 1914) is now in the collection of the Museum of Comparative Zoology and agrees well with a cotype of the Angolan *cryptotis* (M.C.Z. 19268) rather than with the typical form. I believe that this form is to be recognized as a distinct subspecies, *Rana delalandii cryptotis* Boulenger.

Ahl (Sitzber. Ges. naturf. Freunde Berlin, p. 44, 1927) fails to state in what way *signata* and *cacondana* differ from *delalandii* and a careful perusal of his descriptions reveals nothing which would justify their recognition as other than synonyms of *cryptotis* or intermediates between it and the typical form from which they differ in their indistinct tympana. They are said to lack the tarsal tubercle which was said to characterize *cryptotis* but an examination of a long series of the typical form shows that this may be present or absent as is the case also with the small outer, conical metatarsal tubercle.

Rana fuscigula angolensis Bocage.

Rana angolensis Bocage, Jorn. Sci. Lisboa, **1**, p. 73, 1866—Duque de Bragança, Angola; Boulenger, Cat. Batr. Sal. Brit. Mus., p. 50, 1882.

Rana nutti Boulenger, Ann. Mag. Nat. Hist., (8), **18**, p. 467, 1896—Lake Tanganyika.

Rana fuscigula angolensis Loveridge, Bull. Mus. Comp. Zool., **74**, p. 362, 1933.

1 (3595): Benguela, Angola (Ansorge).

58 (12112–21): Bihunga Escarpment, Uganda (Heller, 1925).

62 (12191–2): Lake Bunyoni, Uganda (Heller, 1925).

8 (12195–202): Kalongi, Belgian Congo (Heller, 1925).

14 (12210–23): Ibala, Belgian Congo (Heller, 1925).

The reasons for considering *R. nutti* Boulenger a synonym of *angolensis*, together with a key to the races of *fuscigula*, are given

in the citation above. It might be remarked, however, that the Lake Bunyoni specimens are intermediate between *R. f. angolensis* and *R. f. chapini* in that the webbing of the fifth toe extends part way up the last phalanx.

The largest male measures 59 mm., and largest female 74 mm., both from Kigezi District; those from Bunyoni are but a millimeter or two smaller.

Rana cooperi Parker.

Rana (Ptychadaena) cooperi Parker, Proc. Zool. Soc. Lond., p. 2, 1930 Wouramboulchi, Ethiopia.

1 (12516): Allata, Ethiopia (Osgood, 1926).

This frog has been compared with a paratype of *Rana cooperi* (M.C.Z. 16251) and, though the latter is much smaller, they appear to be specifically identical despite the fact that the Allata specimen possesses vomerine teeth. It will be recalled, however, that Parker's largest paratype, a 52 mm. female, possessed a vomerine tooth on one side only and that in the introduction to his paper Parker presents a very valuable discussion on the absence of vomerine teeth in Ethiopian frogs. It may transpire that *cooperi* should be regarded as a race of *fuscigula* nearest to *angolensis*.

The Field Museum female measures 57 mm.

Rana aequiplicata Werner.

Rana mascareniensis var. *aequiplicata* Werner, Verh. Zool.-Bot. Ges. Wien, **48**, p. 192, 1898—Victoria and Buea, Cameroon.

1 (3579): Efulen, Cameroon (Bates).

Compared with specimens in the Museum of Comparative Zoology from Efulen, Cameroon, and Benito River, Spanish Guinea. From these it differs only in that each digit terminates in a sharp bony claw (somewhat different from that of *Gampsosteonyx*=*Astylosternus*); these claws presumably penetrate the tissues at the breeding season. Total length 44 mm.

Rana oxyrhynchus Smith.

Rana oxyrhynchus A. Smith, Illus. Zool. S. Africa, **3**, pl. lxxvii, figs. 2 and 2a–c, 1849—Kafirland and region of Port Natal; Boulenger, Cat. Batr. Sal. Brit. Mus., p. 51, 1882.

Phrynobatrachus hailensis Meek, Field Mus., Zool. Ser., **1**, p. 175, 1897—Halleh, British Somaliland.

Ptychadena aberae Ahl, Sitzber. Ges. naturf. Freunde Berlin, p. 97, 1923—Abera, near Jamdjam (Sidamo), southwest Ethiopia.

Rana mascariensis (part) Meek (not of Duméril and Bibron), Field Mus. Nat. Hist., Zool. Ser., **10**, p. 403, 1910.

2 (417–8): Halleh, British Somaliland (Akeley, 1896).

3 (2397, 2411, 2415): Nairobi, Kenya Colony (Akeley, 1906).

1 (2418): Athi River, Kenya Colony (Akeley, 1906).

6 (12245, 12247–8, 12262, 12269, 12272): Lake Manka, Tanganyika Territory (Zimmer, 1926).

2 (12532–3): Sheik Hussein, Ethiopia (Osgood, 1926).

1 (12724): Addis Ababa, Ethiopia (Osgood, 1926).

1 (12736): Gendoa River, Dembea, Ethiopia (Osgood, 1927).

2 (12867–8): Katobwe, Belgian Congo (Zimmer, 1926).

3 (18375–7): Bambuni, Belgian Congo (Heller, 1925).

In 1898 Boulenger (Ann. Mus. Civ. Stor. Nat. Genova, **18** (**38**), p. 4) referred *Phrynobatrachus hailensis* Meek to the synonymy of *Rana mascareniensis*. An examination of the types (Nos. 417–8) makes it necessary for me to correct this. Meek was in error in stating that vomerine teeth were absent, for they are present but scarcely discernible as both his specimens were young males. It is curious that he omitted any mention of their sublingual vocal slits and black pouches. The habits, as described by Elliot, are typically those of *oxyrhynchus* and not of a *Phrynobatrachus*.

Ahl's description of *aberae* agrees with the Ethiopian material, and Transvaal *oxyrhynchus*, except that Ahl states that the femur is longer than the foot. Such a proportion would be so unusual that I venture to suggest that the opposite was intended.

The largest male (Katobwe) measures 43 mm. and the largest females (from Sheik Hussein and Bambuni) measure 51 and 52 mm. respectively.

Rana mascareniensis mascareniensis Duméril and Bibron.

Rana mascareniensis Duméril and Bibron, Erpét. Gén., 8, p. 350, 1841 - Madagascar, Mauritius, Seychelles; Boulenger, Cat. Batr. Sal. Brit. Mus., pp. 52, 460, 1882.

Rana mascariensis (sic) Meek (part), Field Mus. Nat. Hist., Zool. Ser., p. 403, 1910.

1 (2425): Nairobi, Kenya Colony (Akeley, 1906).

4 (12001–4): Kisolo, Uganda (Heller, 1926).

10 (12244, 12246, 12263–8, 12270–1): Lake Manka, Tanganyika Territory (Zimmer, 1926).

5 (15091–5): Gatelo, Ethiopia (Albrecht, 1929).

The series have been compared with a cotype of the species (M.C.Z. 1044) from Madagascar. There are four adult males and sixteen females and young. The first finger is equal to, or a trifle shorter than, the second; in none longer (all hands examined). Three joints of the fifth toe, and two and a half or three joints of the fourth toe, webbed, leaving one phalanx of the fifth, and two of the fourth, free of web. The tibio-tarsal articulation of the adpressed hind limb reaches to the nostril in males and some young, to the eye or just beyond the end of the snout in females; this wide range may be observed in females from Lake Manka alone. The largest male measures 39 mm., and female (Nairobi) 53 mm.

Rana mascareniensis uzungwensis Loveridge.

Rana mascareniensis uzungwensis Loveridge, Bull. Mus. Comp. Zool., **72**, p. 384, 1932—Dabaga, Uzungwe Mountains, Tanganyika Territory.

1 (12515): Kitete, Tanganyika Territory (Zimmer, 1926).

This identification is somewhat tentative. On comparison with the type of *uzungwensis* (M.C.Z. 16626) the Kitete frog is found to be still more divergent from the typical form of *mascareniensis* in the webbing of the fifth toe for it has only two joints webbed and two free. All the other toes are webbed like those of *uzungwensis*, which differs from the typical form in having only the two basal joints of the fourth toe webbed and three joints free. The first finger equals the second. The tibio-tarsal joint of the adpressed hind limb marks the nostril. Female measures 39 mm. The Kitete, from which this frog came, is near Mahenge and little more than fifty miles southeast of the type locality of *uzungwensis*.

Rana mascareniensis subsp. indet.

1 (12519): Awadi River, Arusi, Ethiopia (Osgood, 1927).

1 (12706): 25 miles west of Lake Tana, Ethiopia (Osgood, 1927).

These frogs may be distinguished from the typical form by the less extensive webbing on their toes; this is best expressed as follows:

First toe has 1¾ phalanges free and 1¼ phalanges webbed.

Second toe has 1½ phalanges free and 1½ phalanges webbed.

Third toe has 2 phalanges free and 2 phalanges webbed.

Fourth toe has 3 phalanges free and 2 phalanges webbed.

Fifth toe has 2 phalanges free and 2 phalanges webbed.

It will be seen, therefore, that they are very close to *venusta* (see below) which was described from Mongalla. They differ almost enough to be regarded as subspecifically distinct, and perhaps the name *abyssinica* Peters, ,1881 from Ailet near Massawa, Eritrea, or *nilotica* Sentzen, might be applicable. They do not represent *schillukorum* nor *gondokorensis* Werner; nor either *neumanni* or *erlangeri* Ahl, described from this region.

The first finger is equal to, or slightly shorter than, the second; the tibio-tarsal articulation of the adpressed hind limb reaches well beyond the end of the snout in the adult, to the nostril in the young one from west of Lake Tana. Back of the thighs marbled. The adult female measures 52 mm.

Rana mascareniensis venusta Werner.

Rana venusta Werner, Sitzber. Akad. Wiss. Wien, **116**, part 1, pp. 1889 and 1892, pl. iv, fig. 11, 1907—Entebbe, Uganda, Mongalla, and Lagos.

19 (12232): Bambuni, Belgian Congo (Heller, 1925).

1 (12747): Kalongi, Belgian Congo (Heller, 1925).

1 (12748): Bugongo Ridge, Belgian Congo (Heller, 1925).

1 (12759–60): Beni, Belgian Congo (Heller, 1925).

1 (12793): Mambawanga Hill, Belgian Congo (Heller, 1925).

These have been compared with topotypes of the race from Entebbe, Uganda. The form may be distinguished from other races of *mascareniensis* by its larger size and by the webbing of the toes; the character of the toes of the specimens listed, after an examination of every individual, may be stated thus:

First toe has 1½ (or 1) phalanges free and 1½ (or 2) phalanges webbed.

Second toe has 1 phalanx free and 2 phalanges webbed.

Third toe has 2 (or 1) phalanges free and 2 (or 3) phalanges webbed.

Fourth toe has 3 (or 2) phalanges free and 2 (or 3) phalanges webbed.

Fifth toe has 1 phalanx free and 3 phalanges webbed.

The first finger is equal to, or slightly shorter than, the second; the tibio-tarsal articulation of the adpressed hind limb reaches from the nostril to well beyond the tip of the snout in both sexes; the interorbital space is equal to, or larger or smaller than, an upper eyelid, in several specimens two of these conditions may be noted on one individual, showing its uselessness for diagnostic purposes. Back of

the thighs with a clear, regular or irregular line as in the type in all except two young (12747–8). Largest of five males measures 50 mm., of seventeen females 63 mm.

Rana ansorgii Boulenger.

Rana ansorgii Boulenger, Ann. Mag. Nat. Hist., (7), **16**, p. 107, pl. iv, fig. 1, 1905—between Benguela and Bihé, Angola.

1 (3596): Benguela, Angola (Ansorge).

This specimen was received from London identified as *angolensis*. I have compared it with a series of *ansorgii* from Tanganyika Territory (M.C.Z. 16676–85) some of which have been compared with the type. This frog agrees in having only two phalanges of the fifth (outer) toe webbed. Total length 35 mm.

Rana galamensis bravana (Peters).

Limnodytes bravanus Peters, Sitzber. Ges. naturf. Freunde Berlin, p. 3, 1882—Barawa, i.e. Brava, Italian Somaliland.

Rana magretti Scortecci, Atti. Soc. ital. Milano, **68**, p. 182, pl. ix, figs. 1–3, 1929—Ghinda, Italian Somaliland.

Rana fiechteri Scortecci, Atti. Soc. ital. Milano, **68**, p. 248, pl. xii, figs. 2–4, 1930—Villaggio Duca degli Abruzzi, Italian Somaliland.

Rana somalica Scortecci, Atti. Soc. ital. Milano, **69**, p. 320, 1931—Villaggio Duca degli Abruzzi, Italian Somaliland.

12 (12853–6, 12858–9, 12861–6): Katobwe, Belgian Congo (Zimmer, 1926).

The vomerine teeth are between, and continued slightly behind, the level of the choanae; the tibio-tarsal articulation of the adpressed hind limb marks the tympanum in all males and females excepting three (1 male, 2 females) where it reaches the hinder part of the eye. The largest male measures 62 mm., the largest female 86 mm., being matched by one of the same size from Zanzibar.

In 1933, I (Bull. Mus. Comp. Zool., 74, p. 366) remarked that the contention as to whether *Limnodytes bravanus* was distinct from *galamensis* Dum. and Bib. from Galam Lakes, Senegal, could not be settled until Senegal material was available. Since that time Field Museum has received three specimens of the typical form from F. C. Wonder, who collected them from Kedougou, Senegal, and Bamako, French Sudan, in 1934. Mr. Schmidt invited my attention to them and as a result of examining this material I am quite satisfied that the eastern form represents a recognizable race.

I consider that the Katobwe series should be referred to this eastern race though these frogs differ somewhat in the marking on

the posterior aspect of the thighs from both the eastern and the typical form. No structural difference could be found to warrant their separation. The Museum of Comparative Zoology has examples of this eastern form from Bukoba, west of Lake Victoria, and all up the east coast from Zanzibar to Lamu.

In this connection it might be remarked that my friend Dr. G. Scortecci apparently overlooked the description of *bravana* when compiling his list of the amphibia of Italian Somaliland. This resulted in the describing of *fiechteri* and *somalica*, which appear to be inseparable from *bravana*. *R. fiechteri* was based on a 50 mm. frog said to be a male, a point worth checking before the acceptance of my conclusion. *R. somalica* was based on an undoubted male of 63 mm. with characteristic vocal sacs, also two young of 37 and 27 mm. respectively.

Rana albolabris Hallowell.

Rana albolabris Hallowell, Proc. Acad. Nat. Sci. Phila., 8, p. 153, 1856—West Africa; Boulenger, Cat. Batr. Sal. Brit. Mus., p. 59, pl. v, figs. 2 and 2a–b, 1882.

1 (3587): Uganda (Simon).

1 (3588): Efulen, Cameroon (Bates).

The larger specimen measures 43 mm.

Petropedetes newtonii (Bocage).

Tympanoceros newtonii Bocage, Jorn. Sci. Lisboa, (2), 3, p. 270, 1895—Fernando Po; idem, 4, p. 18, pl., 1895.

Petropedetes newtoni Boulenger, Proc. Zool. Soc. Lond., p. 439, 1900.

2 (3628–9): Akok near Kribi, Cameroon (Bates).

These two young males, whose tympana are more than half the orbital diameter, have been compared with the series in the Museum of Comparative Zoology. The latter are from five localities, including Akok. Both frogs measure 34 mm.

Phrynobatrachus natalensis (Smith).

Stenorhynchus natalensis A. Smith, Illus. Zool. S. Africa, 3, Appendix, p. 24, 1849—Port Natal (i.e. Durban, Natal).

Phrynobatrachus natalensis Boulenger, Cat. Batr. Sal. Brit. Mus., p. 112, 1882; Meek, Field Mus. Nat. Hist., Zool. Ser., 7, p. 403, 1910.

1 (2414): Nairobi, Kenya Colony (Akeley, 1906).

2 (2421–2): Lukenya, Kenya Colony (Akeley, 1906).

1 (12761): Beni, Belgian Congo (Heller, 1925).

The Nairobi frog has dried up and is unidentifiable. As, however, *natalensis* is common at Nairobi I accept Meek's identification. Though Meek speaks of only one frog from Lukenya, there are two juveniles similar in appearance to *acridoides* but the latter has more webbing; on these frogs two phalanges of the fifth, and two and a half to three of the fourth, toe are free of web. The Beni frog measures 33 mm.

Phrynobatrachus graueri (Nieden).

Arthroleptis graueri Nieden, Sitzber. Ges. naturf. Freunde Berlin, p. 411, 1910 —Rugege Forest, Belgian Ruanda-Urundi.

Phrynobatrachus graueri Nieden, Wiss. Ergebn. Deutsch.-Zentr.-Afrika Exped., 4, p. 174, pl. v, figs. 2a-b, 1912.

61 (12034-94): Bihunga Escarpment, Uganda (Heller, 1925).

61 (12122, 12162-3): Sabinio Volcano, Uganda (Heller, 1925).

1 (12224): Ibala, Ruwenzori, Belgian Congo (Heller, 1925).

Disk and one, or one and a half, phalanges of the fifth toe free, disk and two phalanges of the fourth toe free of web, the third phalanx of the fourth webbed only as a narrow fringe. The males are much smaller and darker than the fawn-hued females. Most of the Sabinio series are juvenile but some females of 25 mm. are bloated with eggs (circa 25. xii. 1925). These have been in water apparently, for the skin is much smoother and the characteristic dorsal plicae are scarcely noticeable, though present. The largest female (Ibala) measures 27 mm.

Phrynobatrachus dendrobates (Boulenger).

Arthroleptis dendrobates Boulenger, Rev. Zool. Africaine, 7, p. 8, 1919— Medje, Belgian Congo.

Phrynobatrachus versicolor Ahl, Zool. Anz., 61, p. 100, 1924 Rugege Forest, Belgian Ruanda-Urundi.

Phrynobatrachus petropedetoides Ahl, Zool. Anz., 61, p. 102, 1924— Ruwenzori and west of Lake Edward, Belgian Congo.

4 (12016-9): Bihunga Escarpment, Uganda (Heller, 1925).

81 (12141-61): Sabinio Volcano, Uganda (Heller, 1925).

3 (12187, 12189-90): Lake Bunyoni, Uganda (Heller, 1925).

75 (12208, 12226): Mount Ruwenzori, Belgian Congo (Heller, 1925).

1 (12225): Ibala, Mount Ruwenzori, Belgian Congo (Heller, 1925).

These specimens have been compared with topotypes of *dendrobates* and cotypes of *versicolor* and *petropedetoides* (M.C.Z. 17532-3 and 17534-5 respectively) and I fail to find any characters by which they may be distinguished.

Disk and one phalanx of the fifth toe, disk and one phalanx of the fourth toe free of web, the third phalanx of the fourth toe only webbed as a narrow fringe; tibia contained one and three-quarter times to twice in the length from snout to anus. Two very pronounced color types are present, some frogs having a white upper lip, others with the lip marbled with darker. Such coloring is independent of sex. The largest frog measures 38 mm.

Phrynobatrachus plicatus (Günther).

Hyperolius plicatus Günther, Cat. Batr. Sal. Brit. Mus., p. 88, pl. vii, fig. C, 1858—coast of Guinea.

Phrynobatrachus plicatus Boulenger, Cat. Batr. Sal. Brit. Mus., p. 112, 1882.

1 (3647): Ngama, Ogowe River, French Congo (Ansorge).

1 (3648): Akok, near Kribi, Cameroon (Bates).

No phalanx of the fifth toe (being strongly webbed to the disk) and only the disk and one phalanx of the fourth toe free of web. The young Akok frog is rather dried and at first glance appears to have two phalanges of the fourth toe free. These specimens have been compared with the extensive series in the Museum of Comparative Zoology, one of which (M.C.Z. 2753) from Kribi agrees closely with the figure of *auritus* Boulenger, which is believed to be a synonym. The larger frog measures 33 mm.

Phrynobatrachus acridoides (Cope).

Staurois acridoides Cope, Journ. Acad. Nat. Sci. Phila., 6, p. 198, 1867 Zanzibar.

Phrynobatrachus acridoides Boulenger, Cat. Batr. Sal. Brit. Mus., p. 113, 1882.

22 (9999): No locality (Zimmer, 1926).

Disk and one phalanx of the fifth toe, disk and two phalanges of the fourth toe free of web. The largest frog measures 18 mm. compared with the types (M.C.Z. 15026-32).

Arthroleptis variabilis Matschie.

Arthroleptis variabilis Matschie, Sitzber. Ges. naturf. Freunde Berlin, p. 173, 1893—Buea and Barombi, Cameroon.

2 (3634): Bitye, Ja River, Cameroon (Bates).

Compared with specimens from Kribi and Lolodorf, Cameroon, in the collection of the Museum of Comparative Zoology. The tibio-tarsal articulation of the adpressed hind limb reaches the nostril in the male, nostril or eye in four females. Length of male 31 mm., of female 36 mm.

Arthroleptis poecilonotus Peters.

Arthroleptis poecilonotus Peters, Monatsber. Akad. Wiss. Berlin, p. 446, 1863 —Boutry, Ashanti, Gold Coast.

2 (3611–2): Kribi, Cameroon (Bates).

2 (3632–3): Efulen, Cameroon (Bates).

These specimens were originally identified by Boulenger and I believe are correctly determined, though No. 3632 has a metatarsal tubercle as long as the inner toe which has long been regarded as a key character distinguishing *variabilis* from *poecilonotus;* in the other three the metatarsal tubercle is quite definitely shorter than the inner toe. All are of small size, the largest only measuring 25 mm.

Arthroleptis minutus Boulenger.

Arthroleptis minutus Boulenger, Proc. Zool. Soc. Lond., p. 539, pl. xxx, fig. 4, 1895 Durro, western Somaliland, i.e. Ethiopia; Meek, Field Mus. Nat. Hist., Zool. Ser., 7, p. 403, 1910.

1 (6533): Nairobi, Kenya Colony (Akeley, 1906).

This 18 mm. frog is now so macerated that it is of little taxonomic value.

Boulenger refers his readers to Dr. Donaldson Smith's map (Geographical Journal, 5, p. 125, 1895) for information as to localities. There we find no reference to Durro, but to the Darro Mountains located about 7° 15′ N., 41° 10′ E.; in the fine Atlante Internazionale Del Tourny Club Italiano, 1929, however, the Darro Mountains are shown as 8° 6′ N., 40° 40′ E., occupying much the position of the Hedabo Mountains on other maps.

Arthroleptis ogoensis Boulenger.

Arthroleptis ogoensis Boulenger, Ann. Mus. Stor. Nat. Genova, (3), 2, p. 162 pl. i, figs. 7–8, 1906 (1905)—Lambarene, Ogowe, French Congo.

2 (3610): Gaboon, French Congo (Ansorge).

These frogs, identified by Boulenger, are apparently a pair. The inner metatarsal tubercle would appear to be as far from the outer as it is from the tarsal. Both male (black throat) and female (flecked throat) measure 14 mm.

Arthroleptis rouxi Nieden.

Arthroleptis rouxi Nieden, Wiss. Ergebn. Deutsch. Zentr.-Afrika-Exped., 4, p. 178, pl. v, figs. 5a b, 1912—Budu Forest, Uganda.

1 (12123): Sabinio Volcano, Uganda (Heller, 1925).

1 (12188): Lake Bunyoni, Uganda (Heller, 1925).

2 (12230–1): Bambuni, Belgian Congo (Heller, 1925).

I believe that these frogs, all from the central lake region, represent *rouxi* which, in 1928, I incorrectly assigned to the synonymy of *ogoensis*, though there appears to be little to separate them except the black throat of the *ogoensis* males. In these four frogs the inner metatarsal tubercle is as far from the outer as it is from the tarsal (12123, 12188) or nearer the outer than it is to the tarsal (12230–1) though the holotype of *rouxi* was supposed to be distinguished from *ogoensis* by the distance between the two metatarsal tubercles being greater than the distance between the inner and tarsal tubercles. It might be remarked also that the snout, measured from the anterior border of the eye, is longer than the orbit and the interorbital space is equal to an upper eyelid in the Bambuni frogs, greater than an upper eyelid in the Sabinio and Bunyoni specimens. The larger male, which measures 18 mm., and female, measuring 21 mm., are both from Bambuni.

Hemisus marmoratum marmoratum (Peters).

Engystoma marmoratum Peters, Arch. Naturg., 21, p. 58, 1855—Cabaçeira, Mozambique.

Hemisus marmorata Meek, Field Mus. Nat. Hist., Zool. Ser., 7, p. 404, 1910.

1 (2419): Lukenya, Kenya Colony (Akeley, 1906).

Total length 29 mm. as given by Meek.

POLYPEDATIDAE

Chiromantis rufescens (Günther).

Polypedates rufescens Günther, Proc. Zool. Soc. Lond., p. 486, 1868—"West Africa."

Chiromantis rufescens Boulenger, Cat. Batr. Sal. Brit. Mus., p. 92, pl. x, fig. 2, 1882.

2 (3645–6): Bitye, Cameroon (Bates).

The larger frog measures 65 mm.

Leptopelis bocagii (Günther).

Cystignathus bocagii Günther, Proc. Zool. Soc. Lond., p. 481, pl. xxxiii, fig. 2, 1864—Duque de Bragança, Angola.

Hylambates bocagii Boulenger, Cat. Batr. Sal. Brit. Mus., p. 133, figs., 1882.

Hylambates bocagei (sic) Meek, Field Mus. Nat. Hist., Zool. Ser., 7, p. 404, 1910.

1 (2424): Lukenya, Kenya Colony (Akeley, 1906).

This frog measures 34 (not 37) mm.

Leptopelis brevirostris (Werner).

Hylambates brevirostris Werner, Verh. Zool.-Bot. Ges. Wien, **48**, p. 199, pl. ii, figs. 5 and 6, 1898—Victoria, Cameroon.

2 (3641–2): Ja District, Cameroon (Bates).

The larger frog measures 52 mm.

Leptopelis palmatus (Peters).

Hylambates palmatus Peters, Monatsber. Akad. Wiss. Berlin, p. 453, pl. ii, fig. 2, 1868—Ile de Principé.

Leptopelis rufus Reichenow, Arch. Naturg., **40**, part 1, p. 291, pl. ix, figs. 1a and 1b, 1874—Victoria, Cameroon.

Hylambates palmatus Boulenger, Cat. Batr. Sal. Brit. Mus., p. 136, 1882.

2 (3639–40): Efulen, Cameroon (Bates).

These frogs, identified as *rufus* by Boulenger, run down to *violescens* Ahl of Spanish Guinea in the latter's key (Ahl, 1931, Sitzber. Ges. naturf. Freunde Berlin, pp. 186–191). The tibia is included one and three-quarter times in the length from snout to anus. The larger frog measures 55 mm.

Leptopelis aubryi (Duméril).

Hyla aubryi Duméril, Rev. Mag. Zool., (2), 8, p. 561, 1856—Gaboon.

Hylambates aubryi Boulenger, Cat. Batr. Sal. Brit. Mus., p. 135, 1882.

2 (12789–91): Mambawanga Hill, Belgian Congo (Zimmer, 1926).

These frogs compare well with a series from Kribi, Cameroon, in the collection of the Museum of Comparative Zoology. The largest specimen, a female measuring 57 mm., is bloated with enlarged ova.

Leptopelis ocellatus (Mocquard).

Hylambates ocellatus Mocquard, Bull. Mus. Hist. Nat. Paris, p. 413, 1902—fifty kilometers southwest of Lambarene, French Congo.

2 (3637–8): Efulen, Cameroon (Bates).

These specimens were originally identified with *aubryi* of which *ocellatus* is considered a synonym by many authors. I am inclined to think, however, that it may be recognized by its fine markings, particularly by the series of white-edged ocelli (some of which may coalesce) along its flanks. The Museum of Comparative Zoology possesses eight examples from Efulen, Kribi, and the Ja River, Cameroon. The larger frog from Efulen measures 45 mm.

Leptopelis karissimbensis Ahl.

Leptopelis karissimbensis Ahl, Sitzber. Ges. naturf. Freunde Berlin, p. 206, 1929—Kisenji, Lake Kivu, Belgian Ruanda-Urundi.

Leptopelisrugegensis Ahl, Sitzber. Ges. naturf. Freunde Berlin, p. 218, 1929 — Rugege Forest, Belgian Ruanda-Urundi.

1 (12108): Bihunga Escarpment, Uganda (Heller, 1925).

2 (12135-6): Sabinio Volcano, Uganda (Heller, 1925).

These frogs have been compared with a cotype of *rugegensis* (M.C.Z. 17531), a species readily recognizable by the smooth round disks, like breastplates, on the sides of the chest close to the junction of the forearms. I do not recollect having seen these structures in any other member of the genus.

From the description of *rugegensis*, No. 12135 differs in having the tympana scarcely visible though in No. 12108 they are distinct; the tibio-tarsal articulation easily reaches the anterior border of the eye; the tibia is included twice in the length from snout to anus; doubtless this is a sign of youth as it was two and a quarter to two and a third times in the types. When the author states snout as long as the eye or longer, it seems evident that he measured the snout from the nostril. All three frogs are young, the largest measuring only 34 mm.

At my suggestion, Mr. Schmidt later compared them with the description of *karissimbensis* and concluded that the two species are synonymous. The only positive difference is a tarsal spur, such as is barely indicated in Field Museum material, which is said to be present in *karissimbensis*.

Megalixalus fornasinii (Bianconi).

Euchnemis fornasinii Bianconi, Spec. Zool. Mosamb., Rept., pl. v, fig. 1, 1850—Mozambique.

Megalixalus fornasinii Boulenger, Cat. Batr. Sal. Brit. Mus., p. 130, 1882.

1 (12328): Mitiangu, Mahenge, Tanganyika Territory (Zimmer, 1926).

This young frog, measuring 27 mm., is referable to *fornasinii* of which *loveridgii* Procter is a synonym.

Megalixalus dorsalis (Peters).

Hyperolius dorsalis (Schlegel) Peters, Monatsber. Akad. Wiss. Berlin, p. 206, pl. i, fig. 2, 1875—Boutry, Ashanti, Gold Coast and Victoria, Cameroon.

Megalixalus dorsalis Parker, Proc. Zool. Soc. Lond., pp. 900–902, 1931.

5 (12203–7): Kalongi, Belgian Congo (Heller, 1925).

1 (12209): Ibala, Belgian Congo (Heller, 1925).

1 (12940): Kabengere, Belgian Congo (Zimmer, 1926).

Parker (1931) has recently straightened out the confusion into which this frog and the preceding species had fallen since Boulenger, in 1882, placed *dorsalis* in the synonymy of *fornasinii*. I am not certain whether the very young frog from Ibala should be referred to *dorsalis* or some species of *Hyperolius*. The series, apart from this, is composed of three males and three females, the latter distended with ova. Largest male measures 33 mm., female 38 mm.

Megalixalus leptosomus (Peters).

Hyperolius leptosomus Peters, Monatsber. Akad. Wiss. Berlin, p. 619, pl., fig. 5, 1877—Chinchoxo, Portuguese Congo.

Megalixalus leptosomus Boulenger, Cat. Batr. Sal. Brit. Mus., p. 129, 1882.

19 (12914–30, 12981–2): Kabengere, Belgian Congo (Zimmer, 1926).

The series consists of seven males and twelve females. Largest male measures 30 mm., female 32 mm.

Hyperolius spp.

It should perhaps be remarked that the members of this genus are not "species" on the same basis as other amphibians listed in this paper. In many of the forms there is structurally nothing to differentiate them; at the same time they have strikingly different color patterns. Using color pattern as a basis of discrimination, however, is complicated by the fact that in addition to sexual dimorphism in this respect, the young of many species change their pattern on becoming adult while in other species great variation occurs in a single locality. Recently Ahl (1931, Mitt. Zool. Mus. Berlin, **17**, pp. 1–132) has given names to more than ninety of these forms. Some undoubtedly are worthy of recognition, but many may be reduced to subspecific rank, while others will find their way into the synonymy of older species.

The forms represented in the Field Museum collection fall into four main groups if separated on a basis of the amount of webbing on the hind toes. It will be noted that the length of the hind limb in relation to body length, as shown by the point reached by the tibio-tarsal articulation of the adpressed limb, is of little diagnostic service in this genus.

Hyperolius steindachnerii Bocage.

Hyperolius steindachnerii Bocage, Jorn. Sci. Lisboa, 1, p. 75, 1866—Duque de Bragança, Angola.

Rappia steindachneri Boulenger, Cat. Batr. Sal. Brit. Mus., p. 125, 1882.

2 (3618–9): Efulen, Cameroon (Bates).

Webbed to the disk on one side of the first, second, third, and fifth toes; one phalanx free on the fourth. The tibio-tarsal articulation reaches to between the eye and nostril in both. The young male differs considerably from the adult female in coloration; his back is uniformly pale gray, sharply distinct from the side by a broad, dark lateral band; in the female the upper edge of the lateral coloring is very irregular, projecting dark pigmented areas—which often become isolated spots—on to the dorso-lateral region. Young male measures 23 mm., female 29 mm.

Hyperolius ocellatus Günther.

Hyperolius ocellatus Günther, Cat. Batr. Sal. Brit. Mus., p. 88, pl. vii, fig. B, 1858—Fernando Po and Angola.

Rappia ocellata Boulenger, Cat. Batr. Sal. Brit. Mus., p. 123, 1882.

2 (3614-5): Bitye, Cameroon (Bates).

Webbed to the disk on one side of the first, second, third, and fifth toes; one phalanx free on the fourth. The tibio-tarsal articulation reaches to the eye or just beyond. These frogs compare well with Cameroon specimens in the Museum of Comparative Zoology except that they lack a canthal streak. Both are females, the larger measuring 26 mm.

Hyperolius concolor (Hallowell).

Ixalus concolor Hallowell, Proc. Acad. Nat. Sci. Phila., 2, p. 60, 1844—Liberia.

Rappia concolor Boulenger, Cat. Batr. Sal. Brit. Mus., p. 124, 1882.

1 (3621): Budu shore, Lake Victoria, Uganda.

Compared with a topotype (M.C.Z. 12021) from Du River, Liberia.

Webbed to the disk on one side of the first, second, third, and fifth toes; one phalanx free on the fourth. The tibio-tarsal articulation reaches the eye. Female, measuring 25 mm.

Hyperolius pleurotaenius (Boulenger).

Rappia pleurotaenia Boulenger, Ann. Mag. Nat. Hist., (7), **17**, p. 322, 1906—Zima, Cameroon, and Benito River, French Congo.

1 (3613): Efulen, Cameroon (Bates).

1 (3620): Lambarene, French Congo.

These frogs were originally identified as *pusillus* by Boulenger before he described *pleurotaenius*. *H. pusillus*, however, was described from Umvoti, Natal, and after comparing these frogs with adult *pleurotaenius* from Liberia and the Belgian Congo I am dis-

posed to think that they are young of that species. They have a well marked, though narrow, canthal and lateral stripe.

Webbed to the disk on one side of the first, second, third, and fifth toes; one phalanx free on the fourth. The tibio-tarsal articulation reaches the nostril, or between the eye and the nostril. Both are young, the larger measuring 21 mm.

Hyperolius picturatus Peters.

Hyperolius picturatus Peters, Monatsber. Akad. Wiss. Berlin, p. 206, pl. ii, fig. 2, 1875 - Boutry, Ashanti, Gold Coast.

2 (3622–3): Budu shore, Lake Victoria, Uganda.

These frogs are specifically identical with a frog (M.C.Z. 3231) from the same locality and source but received as *Rappia quinquevittata* Bocage. They appear to be identical with larger Kampala, Uganda, frogs which I have referred to *picturatus*.

Webbed to the disk on one side of the first, second, third, and fifth toes; one phalanx free on the fourth. The tibio-tarsal articulation reaches the eye. Both are females, the larger measuring 26 mm.

Hyperolius kivuensis Ahl.

Hyperolius kivuensis Ahl, Mitt. Zool. Mus. Berlin, **17**, p. 26, 1931—Lake Kivu, Belgian Ruanda-Urundi.

11 (12097 100, 12104–7, 12109–11): Bihunga Escarpment, Uganda (Heller, 1925).

4 (12137 40): Sabinio Volcano, Uganda (Heller, 1925).

Webbed to the disk on one side of the first, second, third, and fifth toes; one phalanx free on the fourth. The tibio-tarsal articulation reaches the eye or occasionally the nostril. There is considerable color variation in the series, the dark lateral stripe being present or absent; in general, however, they compare so well with the figure (Ahl, 1931, Das Tierreich, Amphibia, **3**, p. 280, fig. 151) as to leave no doubts as to their identity. Ten males and five females and young. Largest male measures 30 mm., largest female 31 mm.

Hyperolius multicolor Ahl.

Hyperolius multicolor Ahl, Mitt. Zool. Mus. Berlin, **17**, p. 94, 1931—Karisimbi, Belgian Ruanda-Urundi.

5 (12095–6, 12101–3): Bihunga Escarpment, Uganda (Heller, 1925).

256 (12183–6, 12193–4): Lake Bunyoni, Uganda (Heller, 1925).

Compared with a cotype (M.C.Z. 17641) from Karisimbi.

Webbed to the disk on one side of the first, second, third, and fifth toes; one phalanx free on the fourth. The tibio-tarsal articulation reaches the eye or nostril. The majority of these are young and present a lateral stripe which is absent in the adults. A male measures 29 mm., female 32 mm.

Hyperolius graueri Ahl.

Hyperolius graueri Ahl, Mitt. Zool. Mus. Berlin, 17, p. 131, 1931—west of Rusisi River and northwest of Lake Tanganyika, Belgian Congo.

9 (12909, 12949–55, 12983): Kabengere, Belgian Congo (Zimmer, 1926).

Webbed to the disk on one side of the first, second, third, and fifth toes; one phalanx free on the fourth. The tibio-tarsal articulation reaches the eye in all except No. 12953 where it reaches the nostril. All are females, the largest measuring 34 mm.

Hyperolius argentovittis Ahl.

Hyperolius argentovittis Ahl, Mitt. Zool. Mus. Berlin, 17, p. 72, 1931—Ujiji, Lake Tanganyika, Tanganyika Territory.

Hyperolius callichromus Ahl, Mitt. Zool. Mus. Berlin, 17, p. 99, 1931—west of Rusisi River and northwest of Lake Tanganyika, Belgian Congo (restricted).

10 (12912, 12941–8, 12973): Kabengere, Belgian Congo (Zimmer, 1926).

Compared with cotypes (M.C.Z. 17630–1) from west of the Rusisi River.

Webbed to the disk on one side of the first, second, third, and fifth toes; one phalanx free on the fourth. The tibio-tarsal articulation reaches the eye or just beyond in males, eye or nostril in the females. Two males and eight females. Larger male measures 33 mm., largest female 34 mm.

Hyperolius decoratus Ahl.

Hyperolius decoratus Ahl, Mitt. Zool. Mus. Berlin, 17, p. 78, 1931—Longa, Cameroon (also Loanda, Angola).

1 (3616): Benguela, Angola (Ansorge).

Compared with a cotype (M.C.Z. 17632) from Loanda, Angola.

Webbed to the disk on one side of the first, second, third, and fifth toes; one phalanx free on the fourth. The tibio-tarsal articulation reaches the nostril. There is a very strong breast-fold. Female measures 32 mm.

Hyperolius punctulatus (Bocage).

Rappia punctulata Bocage, Herpét. Angola, Lisbon, p. 168, 1895—banks of the Quanza River, Angola.

1 (3617): Dondo, Angola (Ansorge).

This frog was received by Field Museum identified as *marmoratus*. This species it certainly is not and, in the absence of comparative material, I refer it to *punctulatus* with great reservation, having only the original description to guide me.

Whether the locality from whence it comes is identical with Ndondo on the Quanza River I cannot say for certain, though it seems likely. As it was purchased from Rosenberg it would seem probable that its source was the same as a frog listed under *marmoratus* in the British Museum Catalogue (1882) as coming from the Donda River. This may be a tributary of the Quanza.

Webbed to the disk on one side of the first, second, third, and fifth toes; one phalanx free on the fourth. The tibio-tarsal articulation reaches between the eye and the nostril. Color is ashy-gray above; a faint brown line edged above with lighter can be traced from the eye to behind the shoulder; a pair of brown spots, edged with lighter either in front or behind, are present on either side of the dorso-lateral region of the lower back. Male, measuring 26 mm.

Hyperolius striolatus Peters.

Hyperolius striolatus Peters, Sitzber. Ges. naturf. Freunde Berlin, p. 9, 1882—Taita, Kenya Colony.

Rappia ferniquei Mocquard, Bull. Mus. Hist. Nat. Paris, 8, p. 407, 1902—Athi River, Kenya Colony.

Rappia marmorata Meek (not Rapp), Field Mus. Nat. Hist., Zool. Ser., 7, p. 404, 1910—Athi Plains and Lukenya, Kenya Colony.

Rappia cinctiventris Meek (not Cope), Field Mus. Nat. Hist., Zool. Ser., 7, p. 404, 1910—Athi Plains; Lukenya; Kijabe, Kenya Colony.

8 (2308, 2400–3, 2405–6): Athi Plains, Kenya Colony (Akeley, 1906).

6 (2409, 2420, 2423): Lukenya, Kenya Colony (Akeley, 1906).

1 (2431): Kijabe, Kenya Colony (Akeley, 1906).

Webbed to the disk on one side of the first, second, third, fourth, and fifth; webbing narrow on the outer side of the last phalanx of the fourth, practically absent (i.e. an extremely narrow fringe of web) on the inner side. The tibio-tarsal articulation reaches the eye. All the series were not examined as many of them were in too poor a state of preservation. Length of an adult female, 27 mm.

Hyperolius undulatus (Boulenger).

Rappia undulata Boulenger, Ann. Mus. Congo, (1), 2, fasc. 1, p. 4, pl. ii, fig. 2, 1901—Pweto and Lofoi, Belgian Congo.

Rappia symetrica Mocquard, Bull. Mus. Hist. Nat. Paris, 8, p. 408, 1902—Athi River, Kenya Colony.

1 (2412): Nairobi, Kenya Colony (Akeley, 1906).

2 (12315-6): Kitete, Tanganyika Territory (Zimmer, 1926).

6 (12317-21, 12324): Matameras, Tanganyika Territory (Zimmer, 1926).

Both Kitete and Matameras are in the Mahenge District.

Compared with a cotype of *undulatus* (M.C.Z. 15427) from Lofoi.

The Nairobi frog was identified as *marmoratus* by Meek, but omitted from his paper on the Akeley collection. It is now in a very macerated condition.

Webbed to the disk on one side of the first, second, third, and fifth or sometimes half a phalanx free on the first; one phalanx free on the fourth. The tibio-tarsal articulation reaches the eye (Nos. 12317, 12324) or end of the snout (12319, 12321) or between. None has a definite gular disk but those that are apparently males (No. 12316) have the throat granular. The largest frog measures 17 mm.

Hyperolius simus Ahl.

Hyperolius simus Ahl, Mitt. Zool. Mus. Berlin, 17, p. 46, 1931—Usumbura, Lake Tanganyika, Belgian Ruanda-Urundi.

3 (12852, 12860, 12872): Katobwe, Belgian Congo (Zimmer, 1926).

10 (12910, 12956-63, 12980): Kabengere, Belgian Congo (Zimmer, 1926).

This form is very near to *rhodoscelis* with Nyamkolo specimens of which it has been compared; the series differ, however, in possessing a more acuminate snout and sharper canthus.

Webbed to one side of the disk on the second, third, and fifth toes only; one phalanx free on the first and fourth toes. The tibio-tarsal articulation reaches to between the eye and snout in the male and some females, barely to the eye in three of the females. The male measures 28 mm., the largest female 36 mm.

Hyperolius cinnamome-ventris Bocage.

Hyperolius cinnamome-ventris Bocage, Jorn. Sci. Lisboa, 1, p. 75, 1866—Duque de Bragança, Angola.

Rappia cinnamomeiventris Bocage, Herpet. Angola, Lisbon, p. 172, pl. xix, fig. 2, 1895.

6 (12934-9): Kabengere, Belgian Congo (Zimmer, 1926).

Webbed to the disk on one side of the third and fifth toes; one phalanx free on the first, second, and fourth. The tibio-tarsal articulation reaches the posterior border of the eye. The fact that some of these frogs are gravid females precludes the possibility of their being specifically identical with the larger *picturatus* which they somewhat resemble. On the other hand their striking markings still more closely resemble a frog (M.C.Z. 17252) from Kampala, Uganda, which I refer to *picturatus*. Largest female measures 25 mm.

Hyperolius nasutus Günther.

Hyperolius nasutus Günther, Proc. Zool. Soc. Lond., p. 482, pl. xxxiii, fig. 3, 1864—Duque de Bragança, Angola.

Rappia nasuta Boulenger, Cat. Batr. Sal. Brit. Mus., p. 127, 1882.

Rappia granulata Boulenger, Ann. Mus. Congo, (1), 2, fasc. 1, p. 4, pl. ii, fig. 3, 1901 —Pweto, Lake Mweru, Belgian Congo.

1 (12326): Matameras, Tanganyika Territory (Zimmer, 1926).

1 (12869): Katobwe, Belgian Congo (Zimmer, 1926).

3 (12931–3): Kabengere, Belgian Congo (Zimmer, 1926).

Compared with a specimen (M.C.Z. 3230) from Ngola, Angola. Ngola is just north of the type locality.

The terminal phalanx of every toe is free of webbing. The tibiotarsal articulation reaches the nostril in the males, the eye or a little beyond, in the three females. The largest male measures 27 mm., the largest female 23 mm.

I have examined some of the frogs from Vankerckhovenville, Belgian Congo, which were referred by Noble (1924, Bull. Amer. Mus. Nat. Hist., 49, p. 259) to *nasutus* and find that in reality they represent *oxyrhynchus* Boulenger, a species which was described from Pweto and Lofoi, Belgian Congo.

Mocquardia obscura (Boulenger).

Cassina obscura Boulenger, Proc. Zool. Soc. Lond., p. 644, pl. xxxix, fig. 3, 1894 Let Merafia, Shoa, Ethiopia.

Rothschildia kounihensis Mocquard, Bull. Mus. Hist. Nat. Paris, 11, p. 288, 1905 Ouardji, valley of Kounhi, Ethiopia.

Rothschildia obscura Parker, Proc. Zool. Soc. Lond., p. 30, 1930.

Mocquardia obscura Ahl, Das Tierreich, Amphibia Anura, 3, p. 460, fig. 320, 1931.

1 (12514): Allata, Ethiopia (Osgood, 1926).

Though *obscura* has an osseus and Y-shaped omosternum and this Allata frog has a cartilaginous, Y-shaped omosternum I prefer to use the older name, believing that *kounihensis* is a synonym. The

above example of this rare frog also differs from the original description of *obscura* and agrees with *kounihensis* in that the snout is slightly longer than the eye and the interorbital space is much broader than an upper eyelid. However, Parker (1930), after a re-examination of the type of *obscura* finds that it does not differ from *kounihensis* in these characters.

It might be added that the Allata frog possesses a distinct (not indistinct) metatarsal tubercle and that the tarso-metatarsal articulation of the adpressed hind limb reaches to the shoulder (not orbit) and the tibio-tarsal articulation only as far as the elbow. The hind limb is longer than the distance from snout to anus, not equal to it as is the case with *abyssinica* Parker. This female measures 37 mm., its hind limb from the anus 42 mm.

Rothschildia Mocquard (1905) being preoccupied by *Rothschildia* Grote (1896), a New World genus of Heterocera, *Mocquardia* was proposed in substitution by Ahl (1931).

Kassina senegalensis (Duméril and Bibron).

Cystignathus senegalensis Duméril and Bibron, Erpét. Gén., 8, p. 418, 1841 Galam, Senegal.

Cassina senegalensis Boulenger, Cat. Batr. Sal. Brit. Mus., p. 131, 1882; Meek, Field Mus. Nat. Hist., Zool. Ser., 7, p. 404, 1910.

2 (2395, 2413): Nairobi, Kenya Colony (Akeley, 1906).

1 (2404): Athi Plains, Kenya Colony (Akeley, 1906).

1 (12792): Mambawanga Hill, Belgian Congo (Zimmer, 1926).

The largest frog (Congo) measures 37 mm.

BREVICIPITIDAE

Breviceps adspersus Peters.

Breviceps adspersus Peters, Reise nach Mossamb., 3, p. 177, 1882 Damaraland and Transvaal; Hewitt, Ann. Natal Mus., 7, p. 109, pl. vi, fig. 1, 1932.

2 (16006–7): Kleinzee, Cape Province (Wecke, 1931).

Compared with one of Peters' Damaraland cotypes (M.C.Z. 11619). Since these types were in existence, it was unfortunate that Mr. J. H. Power omitted *adspersus* from his monograph of South African members of the genus. Mr. Hewitt is undoubtedly correct in referring his specimens from Quickborn near Okahandja to *adspersus*, for his color description agrees with that of the cotype and also No. 16006, which I assume to be a male. No. 16007 has all pattern obscured and lacks the beard-like markings figured by Hewitt.

In recent years two species of the genus have been described from Port Nolloth (which is near to Kleinzee) but both of them—*macrops* and *namaquensis*—are quite distinct from *adspersus*. In the Kléinzee frogs the snout is included from nine to ten times in the length from snout to anus. The male measures 36 mm., the female 52 mm.

Phrynomerus bifasciatus (Smith).

Brachymerus bifasciatus Smith, Illus. Zool. S. Africa, **3**, pl. lxiii, 1849 "Country to the east and northeast of Cape Colony."

Phrynomantis bifasciata Boulenger, Cat. Batr. Sal. Brit. Mus., p. 172, 1882; Meek, Field Mus. Nat. Hist., Zool. Ser., **7**, p. 404, 1910.

1 (2410): Lukenya, Kenya Colony (Akeley, 1906).

A young 31 mm. frog, as described by Meek.

Phrynomerus annectens (Werner).

Phrynomantis annectens Werner, in Schultze, Denkschr. Med. Naturw. Ges. Jena, **16**, p. 294, 1910—Aar River, Cape Colony.

Phrynomantis nasuta Methuen and Hewitt, Ann. Transvaal Mus., p. 54, pl. xiv, fig. 2, 1911—Kraikluft, Great Karas Mountains, Great Namaqualand, Cape Colony.

Hoplophryne marmorata Ahl, Zool. Anz. Leipzig, **107**, p. 334, fig. 1, 1934—Okahandja, southwest Africa.

2 (3643–4): Benguela, Angola (Ansorge).

These frogs agree well with Werner's description and the excellent figure of *nasuta* which must be regarded as a synonym. *P. annectens* was for long confused with *bifasciatus* Smith. Length of male 30 mm., and female 33 mm. The attributing of one of these almost deserticolous frogs to such a highly specialized rain-forest genus as *Hoplophryne* shows an extraordinary lack of appreciation of the probabilities of distribution.

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SECONDARY SEX CHARACTERS OF CHINESE FROGS AND TOADS

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SECONDARY SEX CHARACTERS OF CHINESE FROGS AND TOADS

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INTRODUCTION

The extensive and varied nature of sexual dimorphism among the Salientia has, from the beginning of modern biology, directed attention to the secondary sex characters of this group of animals. Aside from their intrinsic interest, they have proved to be of great value in the discrimination of species. Careful studies of breeding behavior and experimental studies of the genetic and hormone control of their development and conservation have served to renew and broaden interest in these structures. The best available summary of the extensive literature on this subject is the chapter "Sex and Secondary Sex Characters" in *The Biology of the Amphibia* by G. K. Noble (1931), while for the Chinese species the work of Clifford H. Pope is most comprehensive (1931).

Although the tailless amphibians have been extensively studied, no comparative and systematic account of the secondary sex characters in any large group of species has appeared. The confused state and lack of uniformity in existing descriptions of these characters, particularly in the Chinese fauna, seemed to indicate that a detailed study of them would be of considerable value. My interest in this field began with studies on the sex behavior and secondary sex characters of the frogs and toads of North China. It was during the course of these studies that the peculiar linea masculina, a hitherto unknown secondary sex character, was discovered in *Kaloula borealis*. The linea masculina proves to be characteristic of the males of many species of salientians of various families, and is conspicuous even in the common species used for laboratory dissection in Europe and America (Liu, 1935). Knowing my interest in this topic and in the Chinese amphibian fauna, Professor A. H. Wright suggested a detailed study of the secondary sex characters of the frogs and toads of China, of which this paper is the result. He has given constant and valuable advice, and arranged for my work with other American herpetologists interested in the Chinese fauna. I am deeply indebted to him for his friendly interest.

This paper deals only with the Chinese Salientia available in the various museums of the United States. Special emphasis has been

placed on accurate description of the external secondary sex characters. An effort has been made to bring together all the secondary sex characters of importance in problems of habitat relationship, breeding behavior, and phylogenetic relations by re-examination of characters reported in literature, which has resulted in the discovery of some hitherto unreported. The importance of these characters in the discrimination of species and subspecies is particularly evident in the Salientia. Thus, for example, in *Rana n. nigromaculata* (Plate IV) and *Bufo raddei* (Plate III) sexual dimorphism in color is notable. On the other hand, the head of the male *Rana kuhlii* is remarkably different in shape and size from that of the female. Anyone not aware of this sexual disparity would certainly regard them as distinct species. Among certain species the texture of the skin differs extremely in the two sexes. The length of the hind limbs is a character commonly used in describing salientians, but it is without value if only one sex is considered. In *Bufo bufo japonicus*, for example, the leg of the male is much longer than that of the female, while the female of *Rana macrodactyla* has longer legs than does the male. Only in a very few cases do both sexes have hind limbs of the same length. Other characters which are commonly used to define species are the diameter of the tympanum and the development of the web on the hind foot. Both these structures are usually better developed in the males. The web is much better developed in the males of *Kaloula rugifera*, *Rana japonica* and *Bufo bufo japonicus*, but in *Rana pleuraden* the female has the better-developed web.

Of approximately one hundred known species of Chinese salientians, male and female specimens of sixty-three have been examined. The variation in secondary sex characters has been studied through large series of the common forms.

I am much indebted to the authorities of the various museums whose collections I have been privileged to examine, and especially to Mr. Karl P. Schmidt of Field Museum of Natural History, to Dr. Leonhard Stejneger and Dr. Doris Cochran of the United States National Museum, to Dr. Thomas Barbour and Mr. Arthur Loveridge of the Museum of Comparative Zoology, to Dr. E. R. Dunn of the Academy of Natural Sciences of Philadelphia, and to Dr. G. K. Noble and Mr. Clifford H. Pope of the American Museum of Natural History. I am especially grateful to Mr. Schmidt and to Mr. D. Dwight Davis for their interest in my work and for criticisms and suggestions regarding both studies and manuscript during my

stay at Field Museum of Natural History. The advice of Mr. Pope, who is engaged in monographic studies of the Chinese amphibians and reptiles, has also been of special value, and I have made extensive use of his paper on the Chinese Amphibia (1931). At Peiping, during the spring breeding season, Professor Alice M. Boring of the Biology Department of Yenching University has collected frogs and toads in the interests of my project, and I gratefully extend to her my appreciation of her long-continued help and interest.

SECONDARY SEX CHARACTERS OF THE SALIENTIA

For obvious reasons, an overwhelming proportion of the work on the secondary sex characters of frogs and toads has been confined to the species characteristic of Europe and North America. This is unfortunate from several standpoints. The impoverished salientian fauna of Europe offers an extraordinarily meager field to the student of these interesting structures. On the other hand, while North America is much richer in number of species, the variety of secondary sex characters displayed is scarcely larger than in Europe. No frog on either continent offers anything even remotely comparable to the luxuriant development of nuptial spines, coupled with enormous forearm development, seen in *Rana spinosa*. The reason for this extreme conservatism is not at all apparent. Habitats in North America are as varied as are those found in China.

That China offers an invitingly fertile field for a study of sexual modifications among the Salientia is obvious. The frogs and toads of this region exhibit most of the known types of sexual dimorphism. One of the most remarkable of these characters not found in this fauna is the modification of the snout for digging in male frogs of the genus *Leptodactylus* of tropical America. Other conspicuous modifications, usually confined to a single genus in each case, such as the development of broad spatulate fringes on one or more fingers, the hypertrophy of one of the fingers, the piercing of the tympana by the columella, some distinctive types of glands, the peculiar intromittent organ of *Ascaphus*, and the hair-like dermal growths of *Astylosternus*, do not appear among the species examined in this study, but have been described and discussed by Noble (1931).

Previous students, with few exceptions, have been acquainted only with the conservative structures found in European and North American species. It is largely for this reason that previous attempts to classify salientian secondary sex characters have been found inad-

equate when applied to the Chinese fauna. In the interest of unity, however, it was imperative that some common denominator be used consistently in this study. The scheme finally adopted was to consider the secondary sex characters of each species under several major headings. These are: modifications for grasping; vocal sacs and voice; tympanum; modifications of the skin; characters of the hind limbs; linea masculina; and dimorphism in size.

Finally, to remove any further ambiguity, the following definitions and brief discussions of these headings are added:

Modifications for grasping.—During the breeding season, structural modifications apparently associated with maintaining a firm grip during amplexus are usually developed in males. These usually consist in strengthening of the arms and a varied development of rough pads or spines. The appearance, structure, distribution and the degree of development of these characters vary enormously in the several species. Different genera have various types of modifications of the fingers, the arms, or other parts of the body, and these have been variously named by authors. The wisest procedure in the present instance seems to be to classify them according to structure in order to clarify the descriptions of the individual species which follow. The various types of nuptial pads, asperities, and spines are as follows:

Pigmented areas: More or less horny hard deposits in the skin, not elevated, usually black. Example, edge of mandible of *Bufo bufo gargarizans.*

Nuptial pad: Elevated area, usually well defined, velvety or granular or very finely spinose, pigmentation variable. Example, *Rana japonica.*

Nuptial asperities: Horny spines, in groups, the individual spines distinguishable, black. Examples, *Rana spinosa* (of the fingers), and *Aelurophryne mammata* (of the breast).

Nuptial spines: Pointed horny isolated structures. Examples, *Leptodactylus ocellatus* (prepollex) and *Rana spinosa* (spines on the breast).

Dagger: Projecting pointed bone, piercing the skin, usually the prepollex, sometimes the terminal phalanges of the fingers. Example, *Babina holsti.*

A unique modification of the fingers of the males in a species of *Kaloula* is described by Parker (1934, p. 80), consisting of small bony projections on the terminal phalanges, which correspond with

external dermal pits. It is difficult to imagine what may be the function of this structure.

Vocal sacs.—These are diverticula of the mouth membrane, which may be expanded by inflation with air. They are either external, when the outer skin is modified, or internal, when there is no modification of the external skin. It should be noted, however, that in either case there is an internal sac composed of diverticula of the mouth lining. A more detailed account of this structure has been given in another paper (Liu, 1935), where the principal types of vocal sacs are arranged as follows:

I. Median subgular vocal sac (an unpaired vocal sac beneath the throat).
   - A. Internal median subgular vocal sac as in *Bufo raddei.*
   - B. External median subgular vocal sac as in *Hyla chinensis.*

II. Paired subgular vocal sacs (in subgular region).
   - A. Internal paired subgular vocal sacs as in *Polypedates omeimontis.*
   - B. External paired subgular vocal sacs as in *Rana rugulosa.*

III. Paired lateral vocal sacs (behind and below the angles of the jaws).
   - A. Internal paired lateral vocal sacs (no modification of the external skin) as in *Rana cantabrigensis* and *Polypedates megacephalus.*
   - B. External paired lateral vocal sacs (external skin modified) as in *Rana nigromaculata.*

Tympanum.—The tympanum shows little sex dimorphism in the Chinese Salientia, although there are a few peculiar modifications of this structure in the Old World forms. The male of the African *Petropedetes newtoni* has the columella thrust through the drum and covered by the derm. The tympanum of the American bullfrog, *Rana catesbeiana*, and allied species is very much larger in the males than in the females. The males of *Rana plancyi* and *R. taipehensis*, among Chinese forms, have the tympanum enlarged.

Modifications of the skin.—The differences of texture, warts, ridges, glands and coloration of the skin of the two sexes may be great or slight according to species. Females may be very much more rugose than males as in *Bufo bufo japonicus;* and on the other

hand the females may exhibit a beautiful coloration and smoother skin as in *Bufo raddei*. For satisfactory comparison of the sexes for skin character it is necessary to have specimens preserved alike. Specimens from strong alcohol cannot be compared with those preserved in weak alcohol, and formalin specimens also vary greatly in individual lots.

The looseness of the skin is an interesting and conspicuous character in the large Chinese toad, *Bufo bufo japonicus*, and in *Aelurophryne mammata*. The skin of the males is very loose in comparison with that of the females, due to the presence of loose, spongy connective tissue beneath it. Glands of different shapes and distribution may be found in the skin of either sex. The dermal glands appearing externally in only one sex may be classified as follows:

(1) Snout gland: a gland situated at the snout of the male as in *Rana macrodactyla* and *Polypedates dennysi*.

(2) Subgular gland: a gland found on the throat of the male as in *Hyperolius* spp.

(3) Shoulder gland: a kidney-shaped or oval gland situated at the anterior base of the arm in males as in *Rana guentheri* and *Rana spinulosa*.

(4) Lateral glands: large flat glands found on the sides of the body in males, postero-dorsad of the forelimbs, as in *Rana adenopleura*.

(5) Inguinal glands: rounded glands on the inguinal region of the male as in *Cycloramphus asper*.

(6) Ventral gland: a large flattened gland situated on the belly of males as in *Kaloula rugifera*.

(7) Femoral gland: glandular tissue on the ventral surface of the thighs as in *Mantidactylus luteolus*.

Characters of the hind limbs.—In the majority of Salientia the males have longer legs than the females. It is interesting to find, however, that this is not an invariable rule. In the five species of *Polypedates* examined, the reverse is the case.

Degree of development of webs and fringes on the toes is another important secondary sex character in Salientia. The best examples of sex distinction in this respect are the species of *Kaloula, Bombina, Bufo*, and the wood-frogs. Fringes on the toes are well illustrated by *Bombina* and *Bufo*. In one case hypertrophy of the webs appears in the females (*Rana pleuraden*).

Linea masculina.—This curious structure has been fully described and figured elsewhere (Liu, 1935). It consists of bands of dense connective tissue extending the entire length of both layers of the obliquus muscle, at both their dorsal and ventral borders.

Size.—Sexual dimorphism in size varies greatly. Males are usually smaller than females, but in some forms, such as *Rana spinosa* and its allies, the males are much the larger.

FUNCTIONAL SIGNIFICANCE OF SECONDARY SEX CHARACTERS

In the light of our meager knowledge of the breeding habits of even the common species of frogs and toads, an attempt to consider the functional significance of the sexual modifications of these animals in any but the broadest and most general manner is quite likely to prove sterile. The only recent attempt to view this subject in a broad perspective is that of Noble (1931), and his brief discussion throws but little light on the problem as a whole. Certain modifications, however, function in a manner that is obvious. This is conspicuously true of many of the adaptations in the male for maintaining a firm grip on the back of the female during amplexus. To this class belong the various types of nuptial pads, asperities, spines, and "daggers." To a certain degree the development of these structures seems to be correlated with the breeding habits of the individual species. Thus, the equipment of such species as *Rana spinosa*, *R. phrynoides*, *R. tibetana*, and the wood-frogs (*Rana amurensis*, *R. chensinensis*, and *R. japonica*), is strongly developed, and it can hardly be questioned that this fact is correlated with their mountain torrent habitat. On the other hand, in certain pond-breeding species, such as *Rana plancyi*, *R. fukienensis*, *Ooeidozyga*, *Microhyla*, and *Kaloula* these structures are either poorly developed or entirely absent. Unfortunately this does not hold in many specific instances. Future field observations will show either that the whole theory is unsound (which seems unlikely), or that factors still unknown have superimposed additional modifications.

The situation is further complicated by the fact that species, even within the same genus, seem to have met similar problems with totally different approaches. *Rana spinosa* has solved the problem of breeding in rapidly moving water by developing an astonishing system of mechanical devices. *Rana graminea*, which breeds in similar situations, has apparently been equally successful by reducing the size of the male, thereby lowering his resistance to the water.

It has been suggested frequently that many structures limited to one sex may serve as factors in sex-recognition. In this class fall such modifications as color differences, rugosity of the skin in one or the other sex, and the presence of a substratum of spongy tissue, as in males of *Aelurophryne mammata*, *Bufo bufo japonicus*, and *Bufo b. bankorensis*. At present the best that can be said for this interpretation is that it affords a logical explanation for structures that are otherwise difficult to explain. Any or all of these modifications *may* function in sex-recognition. That they actually do has never been demonstrated. The results of observations and experiments aimed at discovering the method of sex-recognition in Salientia show that voice is probably the most important factor, with differential behavior and the distinctive body form of the female apparently assisting, in certain species at least. Unfortunately, no work has been done on species where sexual dimorphism is great.

Reversal of certain sexual differences is difficult to interpret or understand. For example, the males of all species of *Bufo* have hind legs longer than those of the females, while in *Polypedates* the proportions are reversed and all females have longer legs. In *Rana* the males have longer legs in 61 per cent of the species, females with longer legs occur in 31 per cent, and in 8 per cent both sexes have legs of the same length. Similarly, the dorsal surface of the body is much more rugose in males of *Bufo raddei* than in females, while in *Bufo bufo japonicus* the females are much more rugose than the males.

The functions of the snout glands of *Rana macrodactyla* and of the males of different species of *Polypedates*, the shoulder gland of *Rana guentheri* and *Rana spinulosa*, the ventral gland of the males of all species of *Kaloula*, and the lateral glands of *Rana pleuraden* and *Rana adenopleura*, are unknown.

Beyond a possible correlation with voice production in males, I am unable to suggest any functional significance of the linea masculina.

SECONDARY SEX CHARACTERS OF THE CHINESE SPECIES

Bombina orientalis Boulenger (Plates I, fig. 1; VIII, figs. 1–4).

Modifications for grasping.—Males with well-defined nuptial pads, the largest on the inner side of the forearm. A second, about half as large, covers nearly the entire inner metacarpal tubercle. Smaller and less sharply defined pads are present on the palm and on the arm just above the palm. The first, second, and third fingers

bear pads similar to those of the arm. The arm is distinctly stronger in males with the hand strongly bent inward. The ratio of the average diameter of the lower arm to the body length is 0.11 in the males, while in the females the average ratio is 0.07. The fingers of the males are narrowly fringed. The fringe is widest at the base, diminishing toward the tip.

Vocal sacs.—None.

Skin.—There appears to be no constant difference between the sexes in the rugosity of the skin of the body; the arm and the tarsus in the male are more heavily tuberculate and spinose. There is no sexual difference in coloration.

Hind limb.—The hind limb is slightly longer in the males, ratio to body length averaging 1.22, than in the females, average ratio 1.17. The web in the males is much more extensive than in the females. The tarsus of the male is slightly swollen and the toes are moderately thickened.

Linea masculina.—Absent.

Size.—No sexual dimorphism in size.

Discussion.—I failed to find the difference in the length of the fingers in the males and females described by Stejneger (1907, p. 53). Nor can I agree with Okada's statement (1931, p. 27) that the snout of males is more pointed and that a distinct pad-like swelling appears only on the inner side of the first finger in the breeding season.

Bombina maxima (Boulenger) (Plates I, figs. 2–5; VIII, figs. 5–8).

Modifications for grasping.—In males, a large diffuse nuptial pad covers the inner side of the arm, extending from the distal portion of the upper arm, covering the inner face of the forearm, and two-thirds of the inner metacarpal tubercle. The inner dorsal aspects of the first, second, and third fingers are provided with horny nuptial pads. There are two patches of nuptial pads on the thorax near the base of each arm.

The arm of the male is distinctly larger than that of the female, with the hand strongly bent inward. The average ratio of the diameter of the arm to the body length is 0.144 in the males, and 0.110 in the females. The fingers are much shorter in the males, especially the first, which is bent. The fingers of the male are fringed, rather widely at the base, diminishing toward the tip. The metacarpal tubercle is larger in the males.

Vocal sacs.—None.

Skin.—The skin of the male is more rugose, with minute spines on the back and sides, also present on the limbs. The number of warts is much greater in the male.

Hind limb.—The hind limb is somewhat longer in the males, and the glands on the tarsus and the toes are much better developed. The toes are nearly fully webbed in the male; slightly more than half in the female.

Size.—Females, averaging 56 mm., are larger than males, which average 46 mm. in length.

Aelurophryne mammata (Günther) (Plates II; X, figs. 1, 2).

Modifications for grasping.—In males there are two well-defined patches of nuptial asperities on the breast. These are conspicuously spinose, and black. More strongly developed spines are found on the inner dorsal sides of the first and second fingers, which are strongly curved toward the palm.

The arm is distinctly stronger and bent inward in males. The ratio of the diameter of the lower arm to the body length is 0.183 in eighteen males; while the ratio is 0.103 in females. The first and second fingers are slightly shorter and obviously stronger in the males than in the females.

Vocal sacs.—None.

Skin.—The skin of the males is extremely loose, with numerous wrinkles or folds. In the females, the skin is much more rugose on the dorsum, with various-sized warts; and very numerous small warts are found on the sides, with the throat and median portion of the belly rather smooth. A large quantity of white spongy connective tissue is present between the skin and the muscles in the males; in the females this is not conspicuous. In the males, the margin of the jaws bears black pigmented areas. There is no color dimorphism in alcoholic specimens.

Hind limb.—The hind limb of the male is longer and stronger than that of the female, especially in the tibial region. The toes are much more webbed and strongly fringed in the males than in the females.

Linea masculina.—Absent.

Size.—The male specimens range in size from 58 to 85 mm., averaging 68.6 mm., while the females range from 53 to 74 mm., averaging 64 mm.

Megophrys boettgeri Boulenger.

Modifications for grasping.—There is a well-defined brown nuptial pad on the inner dorsal side of the middle region of the first finger, granular in appearance during the breeding season. The arm is better developed and stronger in the males than in the females.

Vocal sacs.—A median internal subgular vocal sac, with two round openings on the inside near the angles of the jaw, is present. Pope (1931) gives a detailed description of the croak.

Linea masculina.—Absent.

Size.—Sexual dimorphism in size is slight.

Megophrys kuatunensis Pope (Plate VIII, figs. 13, 14).

Modifications for grasping.—Males are provided with two well-defined nuptial pads with brown, uniformly sized, round dots. A large patch covers the inner dorsal side of the middle region of the first finger and a small round patch is found on the dorsal side near the basal region of the second finger. The arm is a little more developed in the males than in the females.

Vocal sacs.—An internal median subgular vocal sac is present, with two round openings in the inner side near the angles of the lower jaw. In some males the skin of the throat is somewhat folded.

Megophrys pelodytoides (Boulenger).

Modifications for grasping.—There is no modification of the fingers during the breeding season. The arm of the male is slightly stronger than that of the single female specimen available for study.

Vocal sacs.—An internal median subgular vocal sac is present, with two round openings nearly at the angles of the jaw. Boulenger (1908, p. 423) states that the throat of the males is brown, which I fail to find.

Hind limb.—The toes of the males are much more fringed than those of the females.

Linea masculina.—Curious to say, there is a well-developed linea masculina in the males of this species, but not in *M. boettgeri* and *M. kuatunensis.*

Size.—Material available is insufficient to prove sexual dimorphism in size.

Bufo bufo japonicus (Schlegel) (Plate VIII, figs. 11, 12).

Modifications for grasping.—Black granular nuptial pads present, consisting of two patches on the inner dorsal surfaces of the first

and second fingers, and a small narrow elongate patch on the inner dorsal margin of the third. The whole surface of the inner metacarpal tubercle, which is larger than in the females, is covered by the black nuptial pad.

The arm is decidedly stronger in males than in females, the ratio of its diameter to the body length being 0.173, against 0.112 in females. The arm of the males is strongly bent toward the thoracic region, as may frequently be seen in preserved specimens collected during the breeding season.

Vocal sacs.—There are no vocal sacs in this species, but during the breeding season the males can produce a low discontinuous sound as a warning croak. They will croak at any season, if lightly pinched back of the arms.

Skin.—The texture and looseness of the skin are decidedly different in the sexes. The skin of the males is very loose, due to a large amount of underlying spongy connective tissue. The warts of the males are large, smooth and fewer in number, so that the skin of this sex is smoother. The warts of the females are usually provided with spines. Males are usually dark green and females light gray in color.

Hind limb.—In the males, the hind limbs are considerably longer and the fringes of the toes and the web are better developed than in the females.

Linea masculina.—Entirely wanting.

Size.—There is a slight dimorphism in size in this species. Females are larger than males.

Discussion.—The peculiar secondary sexual character, the loose skin, is found only in the males of *Aelurophryne mammata, Bufo bufo japonicus* and *Bufo b. bankorensis.* Between the skin and the muscles is a thick layer of loose spongy connective tissue which is white in color, slippery, strong, and very elastic in nature. It may serve as one of the factors for sex-recognition during the breeding season. This character does not seem to have been recognized hitherto.

Bufo bufo gargarizans (Cantor).

Modifications for grasping.—Black granular nuptial pads cover more than two-thirds of the inner dorsal sides of the first and second fingers, and about one-third of the inner dorsal margin of the third finger. A nuptial pad of the same nature is found on the inner side

of the inner metacarpal tubercle. The arm of the male is moderately enlarged and comparatively rougher than that of the female.

Vocal sacs.—None.

Skin.—It is almost impossible to recognize the sexes by the texture of the skin, warts, or coloration in *Bufo b. gargarizans*, in contrast with the directly allied *Bufo bufo japonicus.*

Hind limb.—The hind limb of the males, especially the tibia, tarsus, and foot, is distinctly longer than that of the females.

Linea masculina.—Absent, as in most species of *Bufo*.

Size.—Dimorphism in size is well marked in this species, the females being much the larger. Ten females average 115 mm. in body length, against 85 mm. in an equal number of males.

Bufo bufo bankorensis Barbour.

Modifications for grasping.—The inner dorsal sides of the first and second fingers and the inner margin of the third finger are covered by black granular nuptial pads. A similar pad is found on about two-thirds of the inner ventral portion of the inner metacarpal tubercle. The ratio of the diameter of the lower arm to the body length is 0.144 in the males and 0.106 in the females.

Vocal sacs.—None.

Skin.—The character of the skin is identical with that of *Bufo bufo japonicus* in Peiping. The males are remarkably smooth, with a very loose skin under which a large amount of spongy tissue is found. The warts on the skin of the males are relatively few in number and entirely devoid of spines. In the females, the warts are rather numerous, provided with black spines, and the skin is firm. Males are usually darker in color.

Hind limb.—In the males the hind limb is slightly longer and the webs are better developed.

Linea masculina.—Absent.

Size.—Dimorphism in size is marked, the males being smaller.

Bufo minshanicus Stejneger.

Modifications for grasping.—In this species, the males have brownish black nuptial pads on the inner dorsal aspects of the first and second fingers, with a small patch on the inner dorsal edge of the third finger. The inner ventral surface of the inner metacarpal tubercle is covered by a well-defined patch. The arm of the male is moderately enlarged.

Vocal sacs.—None.

Skin.—The rugosity of the skin is the same in both sexes.

Hind limb.—The males have longer legs.

Linea masculina.—Absent.

Size.—Females are distinctly larger than males, averaging 65 mm. in body length against 56 mm. for males.

Bufo andrewsi Schmidt.

Modifications for grasping.—Black, granular pads are well developed on the inner dorsal sides of the first and second fingers. A third patch covers the inner margin of the third finger, with another small patch on the inner ventral portion of the inner metacarpal tubercle. The arm of the male is a little stronger than that of the female.

Vocal sacs.—None.

Skin.—The skin of the male is somewhat looser and smoother than that of the female.

Hind limb.—In the males, the hind limb appears, from the small series available, to be slightly longer than in the females.

Linea masculina.—Absent.

Size.—Females probably larger than males.

Bufo raddei Strauch (Plates III; VIII, figs. 9, 10).

Modifications for grasping.—Numerous small nuptial pads in males scattered over the inner region of the arm and the whole surface of the inner metacarpal tubercle, which is much larger than that in the female. More strongly pigmented patches are found on the inner dorsal surfaces of the first, second, and third fingers in the males. The arm is larger and more strongly bent in the males. The fingers of the males are slightly fringed and the first finger is strongly curved toward the palm.

Vocal sacs.—The males of this species possess a median subgular internal vocal sac with one or two slit-like openings on the floor of the mouth cavity. Of nineteen males examined, nine have the two openings equally developed; two have the right opening less developed; one the left opening less developed; four have only a right opening and three only a left opening. There are at least two kinds of croak. One is the calling croak, which is very loud and produced with the vocal sac fully inflated, like half a creamy white ball; the notes are of uniform pitch, discontinuous. The other is the

warning croak, which is a low sharp note made when the males are touched or grasped by other males, especially when they are in copula.

Skin.—The skin is much more rugose in males and warts are much more numerous, with groups of dark or deep brown spines. The sexes are very different in coloration. The males are olive green, with a light-colored median stripe and discontinuous lateral stripes on the back, and with groups of deep henna or brown markings. An occasional male may have a color pattern somewhat like that of the female.

Hind limb.—The hind limb is distinctly longer and stronger in males than in females. The foot with the tarsus is slightly longer in the males than in the females. In the males, the inner metatarsal tubercle is stronger and the toes are slightly more fringed than in the females.

Linea masculina.—Absent.

Size.—There is no sexual dimorphism in size.

Discussion.—Pope (1931) states that males are smaller in size, and that this is a constant masculine character. This does not agree with my measurements. For the present study I measured fourteen males and nine females, which were collected when they were paired for breeding. In these there is no sexual dimorphism in size at all. Furthermore, in forty-six adult males and fourteen adult females in the United States National Museum, the average of the body length in males is 58.6 mm., ranging from 45 to 68 mm.; the female average is only 55.8 mm., ranging from 48 to 82 mm.

Bufo melanostictus Schneider.

Modifications for grasping.—The males of this species are provided with well-developed black nuptial pads. The largest patch covers the dorsal side of the first finger, and there is a smaller one on the inner dorsal side of the next finger and a very small one on the inner margin of the distal region of the third finger. Another small, well-defined patch is found on the inner side of the inner metacarpal tubercle. The arms of the males are stronger than those of the females.

Vocal sacs.—A conspicuous median internal vocal sac is present. The vocal sac opening is slit-like. Of fifty-five specimens, fifteen have the two openings equally developed, twenty have only the left opening, sixteen only the right, and in four one opening is vestigial.

Hind limb.—No sign of sexual dimorphism is found in the hind limb.

Linea masculina.—Absent.

Size.—Sexual dimorphism in size is marked; females are larger than males.

Discussion.—The present observations do not wholly agree with those of other authorities. Stejneger (1907, p. 74), Boulenger (1912, p. 272), Van Kampen (1923, p. 80), and Pope (1931) state that males have black nuptial excrescences developed only on the two inner fingers. I find them frequent also on the third finger as in all the species of Chinese *Bufo*. Furthermore, another small patch is found on the inner side of the inner metacarpal tubercle. I find no difference in the webbing of the toes of the two sexes, as described by Stejneger (1907, p. 74) and Okada (1931, p. 57).

Hyla immaculata Boettger.

Modifications for grasping.—A nuptial pad is present on the inner dorsal sides of the first fingers of the males.

Vocal sacs.—Males have a very well-developed external median subgular vocal sac, with two slit-like openings in the inside at the angle of the jaw.

Hind limb.—I fail to detect any significant sexual difference in the hind limb in this species.

Linea masculina.—The male has a well-developed linea masculina.

Size.—Sexual dimorphism is marked; in six specimens of each sex, the length from snout to vent varies from 25 to 30 mm. in males, average 27 mm., and from 27 to 34 mm. in females, average 31.5.

Hyla chinensis Günther (Plate X, figs. 5, 6).

Modifications for grasping.—The males of this species are provided with a well-marked nuptial pad with a pigmented granular skin which covers the inner dorsal side of the basal segment of the first finger. There is no sexual dimorphism in the size of the fore limbs.

Vocal sacs.—An external median subgular vocal sac is present. The skin on the throat is greatly modified, with numerous folds for the expansion of the vocal sac during croaking. The two slit-like openings of the vocal sac are situated near the angles of the jaw.

Linea masculina.—Very conspicuous.

Size.—Males and females are nearly the same in length.

Hyla sanchiangensis Pope.

Modifications for grasping.—A pigmented nuptial pad with a granular appearance covers the inner dorsal side of the basal segment and the inner dorsal surface of the second segment of the first finger. The arm is much stronger in the males than in the females.

Vocal sacs.—The male has a conspicuous subgular external vocal sac with two slit-like openings near the angles of the jaw. The skin over the vocal sac is very loose and is pigmented, especially at the sides. Pope (1931) describes the voice of this species in detail.

Hind limb.—I fail to find any significant difference in the sexes.

Linea masculina.—Well developed.

Size.—Females are slightly larger than males.

Hyla annectans (Jordan).

Modifications for grasping.—A well-defined nuptial pad, with a very fine granular appearance and creamy white in color, is found on the inner dorsal side of the basal segment of the first finger in males.

Vocal sacs.—A very conspicuous external median subgular vocal sac with two slit-like openings is developed in the males.

Hind limb.—The sexes are alike in length of hind limb.

Linea masculina.—Well developed, pink in alcoholic specimens.

Size.—There is no sexual dimorphism in size in this species.

Hyla simplex Boettger.

Modifications for grasping.—The light brown nuptial pad is well developed in this species, on the base of the inner dorsal side of the first finger. The arm of the male is slightly stronger.

Vocal sacs.—A median subgular external vocal sac with two slit-like openings.

Hind limb.—I am unable to find any difference in the sexes in the hind limb.

Linea masculina.—A pink linea masculina is present in alcoholic specimens.

Size.—Sexual dimorphism in size is marked, the males being smaller.

Ooeidozyga lima (Gravenhorst) (Plate X, figs. 3, 4).

Modifications for grasping.—The males of this species are provided with an indistinct nuptial pad on the dorsal side of the basal

segment of the first finger, which is thickened in comparison with that of the female.

Vocal sacs.—There is a median subgular external vocal sac with two short slit-like openings in the inside near the angles of the jaws. Boulenger (1912, p. 225) and Van Kampen (1923, p. 233) state that the vocal sac is internal, but the longitudinal folds of the external skin are clearly developed.

Linea masculina.—A conspicuous pink linea masculina is present in alcoholic males.

Hind limb.—The hind limb is slightly longer in males.

Size.—Males are distinctly smaller than females.

Ooeidozyga laevis martensi (Peters).

Modifications for grasping.—A well-developed, light-colored, nuptial pad is present on the dorsal side of the basal segment of the first finger, which is greatly thickened. The inner dorsal side of the first finger of the female is more darkly pigmented.

Vocal sacs.—The internal median subgular vocal sac has two short slit-like openings on the inner sides near the angles of the jaw.

Hind limb.—There is no significant difference in length of leg in the sexes.

Linea masculina.—A very conspicuous pink linea masculina is present in alcoholic males.

Size.—Males are somewhat smaller than females.

Rana nigromaculata nigromaculata Hallowell (Plates IV; XI, figs. 11, 12).

Modifications for grasping.—A very conspicuous, gray nuptial pad is found on the inner dorsal and inner ventral sides of the first finger of the male. This patch is especially developed on the first segment, which is greatly enlarged in comparison with that of the female. In the males the arm is much stronger than in the females.

Vocal sacs.—The males of this species are equipped with external lateral vocal sacs which are protected by a flap of skin when withdrawn. They are round when fully inflated. There are two distinct kinds of croak, one the warning croak when a male is touched or grasped by another individual of the same sex, and the other the very high-pitched continuous call.

Skin.—The rugosity of the skin varies greatly in this species, and there is no constant difference between the sexes. The males are

variable in coloration. One of the common types is a delicate yellowish green with rather small patches of deeper green scattered irregularly; another common type has an apple green ground-color with black or golden roundish patches irregularly scattered over the entire back. Most of the females have a deep greenish black back with three distinct parallel white stripes.

Hind limb.—The web is usually better developed in the males. The foot of the male is much longer than that of the female.

Linea masculina.—The linea masculina is well developed in the males of this species. It is white in living or freshly preserved specimens and pink in old alcoholic material.

Size.—Sexual dimorphism in size is well marked. Males are smaller than females.

Discussion.—The characters of dorsolateral fold, breadth of head, and shape of snout, regarded as correlated with sex by Okada, (1931, p. 83), do not hold in the living and preserved material studied by myself.

Rana nigromaculata mongolia Schmidt.

Modifications for grasping.—Males with a well-developed gray nuptial pad covering the inner dorsal and inner ventral sides of the first and second segments and the inner margin of the third segment of the first finger. The arm of the male is moderately enlarged.

Vocal sacs.—There are external lateral vocal sacs like those of *Rana n. nigromaculata.* The vocal sac openings are usually round near the inner side of the angle of the mouth. In a few cases they are short and slit-like.

Skin.—In the males, the skin is usually much more rugose than in the females. Sexual dimorphism in coloration is less obvious than in *Rana n. nigromaculata.*

Hind limb.—The web is better developed in some males, but this is not a constant difference.

Linea masculina.—A wide pink linea masculina is present in alcoholic specimens.

Size.—Sexual dimorphism in size is slight.

Rana nigromaculata reinhardtii (Peters).

Modifications for grasping.—Males with gray nuptial pads covering the inner margin of the third segment of the first finger. The arm is a little stronger in the males than in the females.

Vocal sacs.—Vocal sacs are lateral external, like those of *R. n. nigromaculata.*

Linea masculina.—A very conspicuous pink linea masculina is found in alcoholic male specimens.

Size.—Females are distinctly larger than males.

Rana amurensis Boulenger.

Modifications for grasping.—The inner dorsal and inner ventral sides of the first finger of male specimens are covered by a well-developed gray nuptial pad, subdivided into four patches. The first covers the inner ventral basal region of the finger; the second is the largest, spreading over the inner dorsal and inner ventral sides of the distal part of the finger. The other two small patches are found on the dorsal side, and inner and inner ventral side of the last two segments of the finger. There is only one male specimen at hand, but the sexual dimorphism in the diameter of the arm is well marked.

Vocal sacs.—The male of this species has well-developed paired internal subgular vocal sacs just in front of the angles of the mouth. The vocal sac openings are round, near the angles of the jaws.

Skin.—Very numerous fine whitish asperities are developed on the sides, below the dorsolateral folds, in females. The throat of the same sex is more distinctly marbled with brown than that of the males.

Hind limb.—The hind limb is longer in males. I am unable to detect any differences in the web between the sexes.

Linea masculina.—The linea masculina is pink in color in preserved specimens.

Discussion.—A remarkable specific character of the females of this species is the capacity of the oviducts to absorb water. All the females in my collection and in the collection of the Biology Department of Yenching University, Peiping, have their abdomens fully expanded, and in some of them the abdominal wall is ruptured near the pelvic region, where the white jelly-like substance of the enlarged oviduct can be seen. This phenomenon has not been seen in the closely related Chinese wood-frogs of any other species. These peculiar oviducts are used for food in North China, where they are regarded as especially valuable for old people and invalids.

Rana chensinensis David (Plate IX, figs. 7–10).

Modifications for grasping.—The first finger of the male bears a well-developed nuptial pad which is subdivided into four patches by transverse furrows, as in other wood-frogs.

Vocal sacs.—Moderate paired internal subgular vocal sacs are developed in the males, with two round openings near the angles of the mouth.

Hind limb.—The web is much better developed in the male than in the female.

Linea masculina.—A narrow pink linea masculina is found in alcoholic males.

Size.—There is distinct sexual dimorphism in size, though the difference is not great.

Rana japonica Günther.

Modifications for grasping.—The nuptial pads, which are like those of other wood-frogs, are strongly developed during the breeding season. The fore limb of the male is greatly enlarged and is bent strongly toward the breast in males preserved during the breeding season.

Vocal sacs.—The tympanum is slightly larger in males than in females. The tympanum averages 3.8 mm. with a ratio to the body length of 0.077 in eleven males and averages 3.6 mm. with a ratio of 0.075 in seven females.

Hind limb.—The length of the hind limb is slightly greater in males than in females. Webs are much better developed in male specimens. In the male the web reaches the middle of the fourth segment of the fourth toe, while in the female it reaches only to the base of the third segment of the fourth toe, and the web is somewhat more excised in females.

Linea masculina.—A pink linea masculina is found in males in alcoholic material.

Rana spinosa David (Plates VI, figs. 1, 2; X, figs. 9, 10).

Modifications for grasping.—The males have the breast studded with highly developed conical black nuptial spines. Strong spines with a round tubercular base are scattered over the breast proper and smaller ones are found on the posterior portion of the throat and the anterior region of the belly. A varying number of small spines may be present on the margins of the jaws and posterior part of the belly. Back of each arm there are usually a few large spines. More slender and elongate sharp spines form nuptial asperities at the inner dorsal side and the tip of the inner metacarpal tubercle, which is enormously developed; on the inner dorsal side of the first

finger, especially at the region of the joint of the first and second segments; on the inner dorsal side of the second finger; and, a few, on the inner margin of the third finger. The arms of the males are greatly thickened, especially the lower arm. The ratio of the diameter of the lower arm to the body length is 0.179 in the eighteen largest males, and 0.132 in nineteen females.

Vocal sacs.—An internal median subgular vocal sac is developed in the males. The opening of the vocal sac is usually round; in one case (A.M.N.H. 5410), the opening is slit-like.

Skin.—The skin of the male is somewhat looser than that of the female. Usually the throat of the female is more marbled than that of the male.

Size.—Sexual dimorphism is uniform in this character but the difference between the sexes is slight. The average length of males is 100.4 and of females 95.4 mm.

Rana phrynoides Boulenger (Plates VI, figs. 3, 4; IX, figs. 3, 4; X, figs. 7, 8).

Modifications for grasping.—Strong nuptial asperities are developed on the prepollex, and on the inner dorsal sides of the first, second, and third fingers. There are two patches of spines on the breast. In some of the males, very weak spines are found on the sides of the body, the throat, and the palm. The arm of the male is tremendously developed in comparison with that of the female.

Vocal sacs.—A median subgular internal vocal sac with two round openings.

Hind limb.—The hind limb is distinctly longer in males than in females, and the web of the male is slightly better developed.

Linea masculina.—There is no linea masculina in the males of this species, though it is very conspicuous in the males of the closely related forms, *Rana spinosa* and *Rana tibetana.*

Discussion.—Boulenger describes males as having spines on the two inner fingers and Pope (1931) uses this character to distinguish *spinosa* from *phrynoides,* as the former has spines on three fingers. I find that the younger males have spines only on the two inner fingers, but an adult male specimen (No. 2472) in the Museum of Comparative Zoology has spines on the three inner fingers.

It is interesting to find occasional development of male characters in female specimens. A female specimen (No. 2473) in the Museum of Comparative Zoology has spines developed on the pre-

pollex, and on the first and second fingers. Nearly mature ova fill the abdominal cavity.

Rana tibetana Boulenger.

Modifications for grasping.—Nuptial spines are highly developed in the males of this species. Strong spines, each on a round tubercle, are scattered over the middle of the belly and sides of the body; weaker spines with smaller bases are found on the throat, on the dorsolateral parts of the body, and on the posterior parts of the arms and ventral aspects of the legs. The margins of the upper and lower jaws, the sides of the head and the sole of the foot are covered with still finer spines and tubercles. Closely set nuptial asperities are found on the internal apical portion of the inner metacarpal tubercle and on the inner dorsal sides of the first, second, and third fingers.

The arm of the male is distinctly stronger than that of the female, with the basal segment of the first finger greatly enlarged and the tip of this finger bent toward the palm. The eleven largest males and twelve largest females were measured from a series of 140 specimens from Szechwan. The average diameter of the lower arm in eleven males is 24 mm. and in twelve females it is 14 mm.; the ratio of this to the body length is 0.24 in the eleven males and 0.14 in the twelve females. The inner metacarpal tubercle of the males is much larger than that of the females.

Vocal sacs.—Paired lateral internal vocal sacs with two round openings located posteriorly.

Skin.—In addition to the spines mentioned above, the skin of the dorsal sides of the thigh and the hip is much more rugose in males than in females. There is no sexual dimorphism in coloration in alcoholic material.

Hind limb.—The hind limbs of males are much longer than those of females. The dilations of the tips of the toes are distinctly larger in males.

Linea masculina.—The males are provided with a wide pink linea masculina.

Size.—The eleven largest males and twelve largest females, from series of 140 specimens from Szechwan average respectively 107.5 mm. and 99.5 mm.

Discussion.—Two specimens with enlarged arms and nuptial spines (Field Museum Nos. 19031 and 19041a) prove to be females,

with ova and oviducts fully developed. Both these specimens lack the linea masculina, which appears to indicate that this is a strongly fixed male character. Davis and Law (1935) have recently presented experimental evidence on this point. They found that the linea persisted in castrated males of *Rana pipiens*, and failed to appear in females from which the ovaries had been removed.

Rana plancyi Lataste (Plate IX, figs. 1, 2).

Modifications for grasping.—A gray granular nuptial pad is developed on each of the first fingers of the male. A large patch covers the inner dorsal and inner ventral sides of the basal segment of the thumb, and a much smaller patch is found on the inner margin of the second segment of the same finger. The arm of the male is slightly stronger than that of the female.

Vocal sacs.—There are two small internal subgular vocal sacs just on the inner margin of the lower jaws. Externally a very small area of modified skin, which is much thinner in structure and looser in texture, is visible below the angles of the jaw. During the breeding season, a sharp short whistling sound is produced by the males. This kind of vocal sac represents a transitional stage from the internal type to the external and from the subgular to the lateral, as it is subgular internally and lateral externally.

Tympanum.—The tympanum is distinctly larger in the male than in the female, and much closer to the posterior corner of the eye. In the males, the ratio of the diameter of the tympanum to the body length is 0.114, and only 0.086 in the females.

Hind limb.—Measurements show that the hind limb of males is slightly shorter than that of females.

Linea masculina.—Very conspicuous pink bands are found in the alcoholic males.

Size.—Sexual dimorphism in size is well marked in this species, males averaging 46.2 mm., females 60 mm.

Discussion.—Okada (1931, p. 89; pl. 8, fig. 1) describes specimens of *R. plancyi* as a new subspecies of *Rana nigromaculata* under the subspecific name of *chosenica*. From his tables of measurements, his conclusion appears to be due to misidentification of sex in the specimens referred by him to *Rana plancyi*.

Rana fukienensis Pope.

Modifications for grasping.—The males of this species have a well-defined and granular nuptial pad. A large portion of the pad covers

the inner dorsal and inner ventral sides of the basal segment of the thumb, with a smaller portion on the inner margin of the second segment of the same finger. The arm of the male is stronger than that of the female, the ratio of its diameter to the body length being 0.107 in males and 0.093 in females.

Vocal sacs.—The vocal sacs of this species are like those of *Rana plancyi*. The internal sacs are more subgular than lateral and externally there is an indication of modified skin below the angles of the jaw which is more lateral than subgular. The vocal sac openings are round.

Tympanum.—The tympanum is larger in the males, the ratio of its diameter to the body length being 0.100 in males and 0.084 in females.

Hind limb.—The hind limb of the male is somewhat shorter than that of the female.

Linea masculina.—Alcoholic male specimens have a very conspicuous pink linea masculina.

Size.—Males are smaller than females; average body length of four males 42 mm., of eight females 67 mm.

Rana pleuraden Boulenger (Plate XI, figs. 15, 16).

Modifications for grasping.—The inner dorsal side of the basal segment of the first finger of the male is covered by a well-defined creamy white granular nuptial pad.

Vocal sacs.—The males of this species are provided with paired external subgular vocal sacs. The skin on the sides of the throat is thinner than that of the females with inconspicuous longitudinal folds. The vocal sac openings vary greatly. Some have two round openings on the inside of the angles of the jaw, some have two slit-like openings, and some have a round opening on one side and a slit-like opening on the other.

Skin.—There is a very large flat gland on each side of the body in the male, above and behind the shoulder.

Hind limb.—There is a slight difference in the length of the hind limb, the ratio of its length to the body length being 1.59 in the males and 1.64 in the females, the females thus apparently having longer legs than the males, the reverse of the usual relation.

Linea masculina.—A conspicuous pink band is present.

Size.—Sexual dimorphism in size is slight.

Discussion.—The present description of the vocal sacs agrees with Boulenger (1920, p. 91), and differs from Pope (1931, p. 539), who failed to detect the external indications of the vocal sacs.

Rana adenopleura Boulenger.

Modifications for grasping.—A well-defined creamy white granular nuptial pad on the dorsal and distal parts of the first segment of the first finger. The arm of the male is moderately enlarged.

Vocal sacs.—Paired subgular external vocal sacs are found on the sides of the throat, where the skin is slightly modified to form loose longitudinal folds. Two round vocal sac openings are situated on the lateral sides of the floor of the mouth near the angles of the jaw.

Tympanum.—The tympanum is a little larger in males.

Skin.—On the upper posterior side of each arm is a large flattened gland, the lateral gland, of a creamy color. There is no other sexual differentiation in the skin.

Hind limb.—The length of the hind limb is apparently the same in the sexes. A peculiarly interesting character in this species is the better development of the web in females. In the females the webs reach nearly to the distal end of the second segment on the lateral sides of the fourth toe, while in the males only about one-fourth of the second segment of the same toe is webbed.

Linea masculina.—The linea masculina is well defined.

Size.—Females are slightly larger than males.

Rana andersonii Boulenger.

Modifications for grasping.—Light gray granular nuptial pads well developed, covering the inner dorsal side of the basal segment and the inner margin of the second and third segments of the first finger. The arm is a little better developed in males.

Vocal sacs.—Two well-developed external subgular vocal sacs, located at the ventral side of the angle of the jaw. Folds formed by the modified skin run obliquely toward the angle of the jaw.

Tympanum.—The tympanum of the male is much larger than that of the female. The ratio of its diameter to the body length in males is 0.079, and in females 0.044.

Linea masculina.—A well-developed pink linea masculina is found in alcoholic specimens.

Size.—Sexual dimorphism in size is extreme. The sixteen largest males range from 44.49 mm. with an average 46.4 mm.; and the

sixteen largest females range from 87.97 mm. with an average 90.3 mm.

Rana grahami Boulenger (Plate VIII, figs. 15, 16).

Modifications for grasping.—A large gray granular pad on the inner dorsal side of the basal segment of the first finger and a very much less developed pad on the second and third segments of the same finger. The arm of the male is somewhat stronger than that of the female.

Vocal sacs.—Males have paired subgular internal vocal sacs with two round openings.

Hind limb.—The legs are slightly longer in males than in females and the web is better developed in males.

Linea masculina.—In preserved males there is a conspicuous pink linea masculina.

Size.—Sexual dimorphism in size is well marked.

Rana chunganensis Pope.

Modifications for grasping.—A nuptial pad with a granular surface, creamy white in color, is well developed. It covers the inner dorsal side of the basal segment and the inner margin of the second and third segments of the first finger. The arm is moderately enlarged in males.

Vocal sacs.—The males of this species are provided with paired external subgular vocal sacs with two round openings near the angles of the jaw.

Linea masculina.—The linea masculina appears to be entirely absent in this species.

Rana graminea Boulenger (Plate X, figs. 11, 12).

Modifications for grasping.—A well-developed light-colored nuptial pad covers the inner margin of the inner metacarpal tubercle, the inner dorsal side of the basal segment and the inner edge of the rest of the segments of the first finger. The basal portion of the thumb is greatly enlarged but the inner metacarpal tubercle is not as conspicuous as in females. The arms are much more strongly developed in males.

Vocal sacs.—Very conspicuous paired external subgular vocal sacs are present. They are not purely subgular in position, as in *Rana rugulosa*, but represent an intermediate type between the lateral and subgular positions.

Tympanum.—The tympanum of males is much larger than that of females. The ratio of its diameter to the body length is 0.100 in males and 0.085 in females. The tympanic membrane in the males is much more transparent.

Skin.—In the females, the skin on the dorsal side is much more rugose than in the males. Smith and Pope state that the coloration of the males is more uniformly green than that of the females.

Linea masculina.—Absent.

Size.—Sexual dimorphism in size is remarkable. The sixteen largest males range from 44.52 mm. with an average of 47.6 mm., while in the eleven largest females the range is from 84 to 108 mm. with an average of 101.9 mm.

Rana guentheri Boulenger (Plate XI, figs. 9, 10).

Modifications for grasping.—The nuptial pads on the inner dorsal sides of the thumbs are only slightly developed in this species.

Vocal sacs.—Paired subgular external vocal sacs with round openings situated near the commissures of the jaw.

Tympanum.—The diameter of the tympanum is greater in the male than in the female. The average measurement in ten large males is 5.6 mm. (ratio to body length 0.086), and 4.8 mm. in ten large females (ratio to body length 0.072).

Skin.—There is a prominent kidney-shaped gland at the anterior base of each arm, below the postrictal glandular fold, in males. The postrictal fold itself is much more conspicuous in males than in females.

Linea masculina.—A conspicuous linea masculina is present in alcoholic material.

Size.—Females are slightly larger than males.

Rana kuhlii Duméril and Bibron (Plates V, figs. 1–4; XI, figs. 1, 2).

Modifications for grasping.—A large nuptial pad covers the dorsal, inner, and inner ventral sides of the first finger, and a smaller pad is found on the inner dorsal side of the second finger. Another elongated and well-defined pad is found on the inner posterior region of the distal end of the lower arm, near the base of the first finger. The arms of the males during the breeding season are slightly stronger than those of the females.

Vocal sacs.—Not yet found in this species; field studies are required, as the skin of the throat is loose and folded.

Skin.—The skin of the back and sides is much more rugose in males than in females.

Linea masculina.—A conspicuous pink linea masculina is present in alcoholic specimens.

Special secondary sex characters.—The males of this species have a very large depressed head. The ratio of the length of the head to the body length (without head) is 0.82 in the males and 0.56 in the females. The head of the male is longer than wide, while in the female the measurements are about equal. Two bony prominences in the front of the lower jaw are much better developed in males than in females.

Discussion.—Boulenger (1920) states that the males have no vocal sacs, and the fore limbs are without nuptial excrescences. Pope (1931) gives a detailed description of the secondary sex characters of this species, but he did not observe the nuptial pad on the distal end of the arm and on the second finger.

Rana latouchii Boulenger.

Modifications for grasping.—A well-developed nuptial pad is found on the inner dorsal side of the basal segment of the first finger of the males. The arm is much stronger in males.

Vocal sacs.—Paired internal subgular vocal sacs with two round openings are present.

Hind limb.—The hind limb of the male is slightly longer than that of the female, and the web is much more fully developed.

Linea masculina.—A pink linea masculina is present.

Size.—Sexual dimorphism in size is marked. The range in size of the sixteen largest males is from 35 to 40 mm., averaging 37.3 mm., and from 40 to 50 mm., averaging 46.4 mm., in the sixteen largest females.

Rana limnocharis Wiegman (Plate XI, figs. 3, 4).

Modifications for grasping.—There are two feebly separated nuptial pads. One covers the inner portion of the inner metacarpal tubercle and the inner basal part of the thumb; the other patch is found on the dorsal side of the first finger.

Vocal sac.—The males of this species are provided with a median subgular external vocal sac, usually with two slit-like openings

situated near the corners of the mouth. The skin of the throat of the males forms loose folds. Males produce a discontinuous sharp high croaking during the breeding season or during rains in summer.

Linea masculina.—A fine pink linea masculina is present.

Size.—The average length of the body in the twenty largest females is from 46 to 48 mm. and 39.2 mm. in the twenty largest males of the same series, of more than four hundred specimens from Szechwan in Field Museum. This corresponds closely to the average of 43.6 mm. in the thirty-one females and 37.9 mm. in the twenty-four males in the United States National Museum.

Discussion.—Stejneger (1907, p. 129) and Boulenger (1920, p. 29) state that males of this species have paired external vocal sacs. The anatomy of many males and observations of croaking in life, show that there is only one median subgular external vocal sac with two latero-posterior lobes. Males of this species are provided with distinctly slit-like openings to the vocal sac, like those of *Bufo*, which are most unusual in *Rana*.

Rana macrodactyla (Günther) (Plate XI, figs. 5, 6).

Modifications for grasping.—In the male a definite white granular nuptial pad is found on the inner dorsal side of the basal segment of the first finger.

Skin.—There is a prominent elevation on the tip of the snout in males.

Hind limb.—The hind limb is slightly longer in the females.

Linea masculina.—Present.

Size.—The average length of males examined is 28.5 mm. It is 39.6 mm. in females.

Discussion.—Boulenger (1920, p. 156) states that the male is devoid of secondary sex characters. I find that the male of this species can easily be distinguished by the prominence on the snout, larger tympanum and the nuptial pad on the inner dorsal side of the first finger.

Rana montivaga Smith (Plate IX, figs. 11, 12).

Modifications for grasping.—A well-developed gray granular nuptial pad covers the inner dorsal side of the thickened first finger. The forearm is much stronger in males.

Vocal sacs.—Mature males have small paired subgular internal vocal sacs with round openings situated near the angles of the jaws.

These vocal sacs and vocal sac openings are found only in two males, one 51 mm. in length and the other 44 mm. They are absent in a male 42 mm. in length and in another male with a body length of 41 mm. It is interesting that the vocal sacs and vocal sac openings apparently do not develop until the animal is sexually mature.

Linea masculina.—The linea masculina is wanting in the males of this species available for examination.

Rana rugulosa Wiegman.

Modifications for grasping.—Males of this species are provided with a moderately developed nuptial pad which covers the inner dorsal side of the first two segments and the inner edge of the third segment of the first finger. There is no difference in the development of the fore limbs in the sexes.

Vocal sacs.—Well-developed external subgular vocal sacs, forming longitudinal folds on each side of the throat with round openings near the angles of the jaws.

Linea masculina.—Very conspicuous in alcoholic specimens.

Size.—Females are larger than males, averaging 109 mm. in body length as compared with 91 mm. in males.

Rana spinulosa Smith (Plate XI, figs. 7, 8).

Modifications for grasping.—A conspicuous nuptial pad on the inner dorsal side of the basal segment of the first finger. The arm of the male is somewhat stronger than that of the female.

Vocal sacs.—Paired subgular vocal sacs, just distinguishable externally. The round openings are near the angles of the jaws.

Skin.—I am unable to find any difference in the skin in the sexes except the shoulder glands of the males, situated at the anterior side of the basal part of the arm.

Linea masculina.—The linea masculina is present but inconspicuous and white in color in preserved males.

Size.—Males appear to be distinctly smaller than females.

Rana taipehensis Van Denburgh (Plate XI, figs. 13, 14).

Modifications for grasping.—Wanting in this species.

Tympanum.—The tympanum of the male is much larger than that of the female.

Vocal sacs.—Absent.

Hind limb.—The hind limbs are longer in female than in male specimens. The ratio to the body length is 1.66 in the single male available and 1.82 in the ten females.

Linea masculina.—A white linea masculina is present in the preserved male.

Staurois ricketti (Boulenger) (Plate IX, figs. 5, 6).

Modifications for grasping.—A large patch of nuptial asperities with unpigmented coarse granules covers the inner dorsal side of the basal segment of the first finger. The arm is slightly stronger in the male.

Skin.—The skin is rather rugose on the sides of the body in males.

Hind limb.—The leg of the male is slightly longer than that of the female. This difference is chiefly due to the greater length of the tibia and of the foot with tarsus in the males. In this species the diameter of the thigh is greater in the males (0.256 mm.) than in the females (0.222 mm.).

Linea masculina.—Wanting in this species.

Size.—Males are slightly smaller than females.

Polypedates dennysi (Blanford) (Plate VII).

Modifications for grasping.—Two patches of light-colored nuptial pads, one on the inner dorsal side of the basal segment of the first finger with a narrow projection along the inner margin to the base of the disk; and another smaller well-defined patch on the distal region of the inner dorsal portion of the first segment of the second finger. The lower arm of the male is slightly stronger than that of the female. In the female, the inner metacarpal tubercle is better developed and with a sharper inner edge; in the male, the inner edge is covered by the nuptial pad.

Vocal sacs.—An internal median vocal sac with two slit-like openings.

Skin.—The skin is more rugose, especially on the limbs, in the males. The disks on the fingers of the females are slightly larger than those of the males.

Linea masculina.—The linea masculina is pink and conspicuous.

Size.—Sexual dimorphism in size is well marked. The eighteen males range from 77.5 to 93 mm. with an average of 86.6 mm.; and the fifteen largest females range from 99 to 112 mm. with an average of 106.4. The body of the male is much more slender than that of the female.

Discussion.—The males of this species, like other *Polypedates*, have a more pointed fleshy snout than the females. This character does not seem to have been mentioned in previous literature.

Polypedates leucomystax (Gravenhorst).

Modifications for grasping.—A creamy white nuptial pad covers the inner dorsal side of the first finger, with a much smaller pad on the dorsal side of the basal segment of the second finger. The disks on the fingers are larger in the females than in the males. The diameter of the lower arm is nearly the same in both sexes.

Vocal sacs.—An internal median subgular vocal sac with two short slit-like openings.

Linea masculina.—A narrow pink linea masculina is found in the males.

Size.—Dimorphism in size is well marked, sixteen large males averaging 50.1 mm. in body length, while sixteen large females have an average of 70.1 mm.

Polypedates megacephalus Hallowell.

Modifications for grasping.—Two patches of granular, creamy white nuptial pads, the larger on the inner dorsal side of the first finger, with another much smaller one on the inner basal segment of the second finger. The disks on the fingers are considerably smaller in the males than in the females.

Vocal sacs.—Paired internal lateral vocal sacs, instead of the single internal median vocal sac of *P. leucomystax*, indicate that this is a distinct species.

Linea masculina.—Very conspicuous.

Size.—Sexual dimorphism in size is marked, the sixteen largest males ranging in length from 45 to 52 mm. with an average of 48 mm., and the sixteen largest females from 60 to 69 mm. averaging 64.3 mm.

Polypedates omeimontis Stejneger (Plate IX, figs. 13, 14).

Modifications for grasping.—Two patches of creamy white nuptial pads, the larger on the inner dorsal side of the first finger and the smaller on the distal portion of the first segment of the second finger. The disks of the fingers are slightly better developed in the females than in the males. The average diameter of the disk of the third finger is 5.7 mm., with a ratio to the body length of 0.08 in the females, while in the males the average is 4 mm., with a ratio of 0.57.

Vocal sacs.—Vocal sacs internal, with two long slit-like openings, as in toads.

Snout.—The snout of the males is much more pointed, with a thick fleshy tip which is not found in the females. This character is best developed in *Polypedates dennysi.*

Linea masculina.—A narrow white linea masculina is present.

Size.—The females are distinctly larger than the males, the average of the body length being 69.6 mm. in the females and 55.7 in the males.

Polypedates oxycephalus (Boulenger) (Plate XII, figs. 3, 4).

Modifications for grasping.—A conspicuous light-colored nuptial pad covers the whole inner dorsal surface of the first finger, which is greatly enlarged during breeding season. Another much smaller patch covers the inner edge of the middle portion of the basal segment of the second finger. The disks on the fingers are smaller in the males, especially the disk of the first finger. Males have slightly stronger arms than females.

Vocal sacs.—An internal median vocal sac is present.

Snout.—The snout of the male is much more pointed than that of the female.

Hind limb.—The legs are slightly longer in females than in males. Females have larger disks on the toes.

Linea masculina.—I fail to find any linea masculina in this species.

Size.—Females are much larger than males.

Philautus doriae Boulenger.

Modifications for grasping.—This species appears to have no nuptial pads or other modifications for grasping.

Vocal sacs.—The male has an internal median subgular vocal sac with short slit-like openings.

Hind limb.—The hind limbs of the males are slightly longer than those of the females.

Linea masculina.—Conspicuous and pink in color in alcoholic specimens.

Size.—The average size of males is 21.1 mm., with a range of 19 to 23 mm., and 26.6 mm. in the females, with a range of 23 to 30 mm.

Philautus vittatus Boulenger.

Modifications for grasping.—A well-defined nuptial pad covers the inner dorsal side of the basal segment of the first finger in the male.

Vocal sacs.—Males have an internal median subgular vocal sac with short slit-like openings near the angles of the jaws.

Linea masculina.—A light pink linea masculina is present in alcoholic specimens.

Size.—Sexual dimorphism in size is slight. Males are smaller than females.

Kalophrynus pleurostigma (Mueller).

Modifications for grasping.—There are no modifications for grasping except that the arm of the male is slightly stronger than that of the female. The ratio of the diameter of the lower arm to the body length is 0.088 in males and 0.074 in females.

Vocal sacs.—An internal median subgular vocal sac with two slit-like openings is present in male specimens. Very slight indications of looser and darker skin on the throat indicate the vocal sac externally.

Linea masculina.—Conspicuous in alcoholic male specimens.

Size.—Male specimens average 36 mm. in body length, and females average 43 mm.

Kaloula borealis (Barbour) (Plate XII, figs. 5, 6).

Modifications for grasping.—There is little modification in the males for grasping during the breeding season, except that the males have arms a little stronger than the females. The ratio of the diameter of the lower arm to the body length is 0.10 in the sixteen largest males and 0.08 in the sixteen largest females.

Vocal sacs.—Males of this species are provided with an external median subgular vocal sac, strongly pigmented externally, with long slit-like openings near the angle of the jaw.

Skin.—A peculiar secondary sex character may be seen in the males of the Chinese species of *Kaloula* in the modification of a part of the ventral skin. In *Kaloula borealis,* the male has a modified U-shaped patch of thickened, granular, and darker skin on the thoracic region between the arms.

Hind limb.—In the males, the web is much more fully developed and the toes are better fringed than in the females. There is no sexual dimorphism in the length of the hind limb.

Linea masculina.—The linea masculina was first discovered in this species, since the skin on the belly is so thin and transparent that the two wide white (rarely pink) bands may be seen in living specimens.

Kaloula rugifera Stejneger (Plates IX, figs. 17, 18; XII, figs. 9, 10).

Modifications for grasping.—The basal portion of the thumb is slightly enlarged and lighter in color, with no other grasping modifications.

Vocal sacs.—A median subgular internal vocal sac, with two slit-like openings on the floor of the mouth, is present.

Skin.—In males, a thickened area of glandular skin covers the whole belly, which is much lighter in color than that of females.

Hind limb.—In the males the toes are fully webbed, while they are only about one-third webbed in the females.

Linea masculina.—A wide pink band in the males.

Kaloula verrucosa (Boulenger) (Plates IX, figs. 15, 16; XII, figs. 7, 8).

Modifications for grasping.—Males are almost without modifications for grasping, except that the lower arm is a little better developed. Parker (1934, p. 80, figs. 35, 36) has described the peculiar pits of the tips of the fingers associated with bony points and knobs on the terminal phalanges.

Vocal sacs.—An external median subgular vocal sac, with long slit-like openings in the inner side of the lower jaw, is present. Skin of the throat over the vocal sac is strongly pigmented, with a very fine white median line.

Skin.—A large modified area of skin is present on the belly of the males.

Hind limb.—The males have the toes much more fully webbed.

Linea masculina.—A very conspicuous linea masculina is present.

Size.—Sexual dimorphism in size is slight, the average body length being 41.6 mm. in the males, and 44.7 mm. in the females.

Microhyla butleri Boulenger.

Modifications for grasping.—I fail to find any modification in the males for the purpose of grasping during the breeding season.

Vocal sacs.—Males can readily be distinguished by the dark-colored external median vocal sac, with a skin fold formed by the posterior extension of the vocal sac crossing the breast just anterior to the insertions of the arms.

Linea masculina.—A conspicuous pink linea masculina is present.

Microhyla heymonsi Vogt (Plate XII, figs. 1, 2).

Modifications for grasping.—None.

Vocal sacs.—An external median subgular vocal sac is well developed, with a skin fold formed by the posterior extension of the vocal sac crossing the breast just anterior to the insertion of the arm. The skin of the sac is much more pigmented and a little more rugose than that of the females.

Linea masculina.—A pink linea masculina is always present in the males.

Microhyla ornata (Duméril and Bibron).

Modifications for grasping.—None.

Vocal sacs.—A median subgular external vocal sac with slit-like openings near the angles of the jaws.

Linea masculina.—A bright pink linea masculina is found in alcoholic specimens.

Microhyla pulchra (Hallowell).

Modifications for grasping.—There is no sign of any modification for grasping during the breeding season in the males of this species.

Vocal sacs.—An external median subgular vocal sac has a skin fold at its posterior border crossing the breast just anterior to the fore limbs. The skin covering the vocal sac is darker, thicker, and more rugose in males.

Linea masculina.—The sex can always be distinguished by the pink linea masculina in the males.

Hind limb.—The hind limb is slightly longer in males. Its ratio to the body length is 1.92 in sixteen males and 1.80 in sixteen females.

Size.—Sexual dimorphism in size is well marked, the average of sixteen males being 23.5 mm., while in sixteen females it is 28.1 mm.

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EXPLANATION OF PLATES

PLATE I

Fig. 1. *Bombina orientalis*, three males, to show strong bending of arms.

Fig. 2. *Bombina maxima*, to show enlarged arm and well-developed web in male.

Fig. 3. *Bombina maxima*, female, to show slender arm and less developed web.

Fig. 4. Ventral view of male *Bombina maxima*, to show nuptial pads on fingers and breast, strong arm, and more developed web.

Fig. 5. Ventral view of female of *Bombina maxima*.

PLATE II

Aelurophryne mammata

Fig. 1. Male, dorsal view, to show looseness of skin, enlarged arm, and shape of body.

Fig. 2. Female, to show differences from male.

Fig. 3. Male, ventral view, to show nuptial spines in two groups on breast, nuptial spines on fingers, and nuptial asperities on anterior ventral margin of jaw.

Fig. 4. Female, ventral view, to show differences from male.

PLATE III

Bufo raddei

Fig. 1. Typical male coloration.

Fig. 2. Ventral view of same animal, to show nuptial pads.

Fig. 3. Rare type of male color pattern.

Fig. 4. Typical female, to show color pattern.

Fig. 5. Another type of female coloration.

PLATE IV

Rana nigromaculata nigromaculata

Fig. 1. Type of male color pattern.

Fig. 2. A second type of male color pattern.

Fig. 3. Variant male coloration.

Fig. 4. Variant male coloration.

Fig. 5. Rare type of male coloration approaching coloration of females.

Fig. 6. Typical female.

PLATE V

Rana kuhlii

Fig. 1. Dorsal view of male, to show long and broad head.

Fig. 2. Female, to show shorter and narrow head.

Fig. 3. Ventral view of male.

Fig. 4. Ventral view of female.

PLATE VI

Fig. 1. *Rana spinosa*, ventral view of male, to show nuptial spines, nuptial asperities, and enlargement of arm.

Fig. 2. *Rana spinosa*, ventral view of female.

Fig. 3. *Rana phrynoides*, ventral view of male, to show same characters as those of male *Rana spinosa*.

Fig. 4. *Rana phrynoides*, ventral view of female with a few nuptial asperities on first finger and on prepollex (abnormal).

PLATE VII

Polypedates dennysi

Fig. 1. Male, to show the slender body and pointed snout.
Fig. 2. Female, to show stouter body and blunt snout.
Fig. 3. Ventral view of male.
Fig. 4. Ventral view of female.

PLATE VIII

Fig. 1. *Bombina orientalis*, hand and arm of male, to show nuptial pad and thicker arm.
Fig. 2. *Bombina orientalis*, hand and arm of female.
Fig. 3. *Bombina orientalis*, foot of male, to show better-developed web.
Fig. 4. *Bombina orientalis*, foot of female.
Fig. 5. *Bombina maxima*, hand and arm of male, to show nuptial pad, stronger arm, and bending of the hand.
Fig. 6. *Bombina maxima*, hand and arm of female.
Fig. 7. *Bombina maxima*, foot of male, to show better-developed web.
Fig. 8. *Bombina maxima*, foot of female.
Fig. 9. *Bufo raddei*, hand and arm of male, to show nuptial pads on arm and fingers, and stronger arm.
Fig. 10. *Bufo raddei*, hand and arm of female.
Fig. 11. *Bufo bufo japonicus*, hand and arm of female.
Fig. 12. *Bufo bufo japonicus*, hand and arm of male, to show nuptial pads on three inner fingers, and stronger arm.
Fig. 13. *Megophrys kuatunensis*, hand of male, to show nuptial pads on two inner fingers.
Fig. 14. *Megophrys kuatunensis*, hand of female.
Fig. 15. *Rana grahami*, hand and arm of male, to show nuptial pad on the first finger and its enlargement.
Fig. 16. *Rana grahami*, hand and arm of female.

PLATE IX

Fig. 1. *Rana plancyi*, hand of male, to show enlargement of first finger and nuptial pad.
Fig. 2. *Rana plancyi*, hand of female.
Fig. 3. *Rana phrynoides*, hand and arm of male, to show thickness of arm and nuptial asperities on two inner fingers.
Fig. 4. *Rana phrynoides*, hand and arm of female, to show abnormal development of nuptial asperities on first finger.
Fig. 5. *Staurois ricketti*, hand of male, to show strongly developed prepollex and nuptial pad on it.
Fig. 6. *Staurois ricketti*, hand of female.
Fig. 7. *Rana chensinensis*, foot of female.
Fig. 8. *Rana chensinensis*, foot of male, to show better-developed web.
Fig. 9. *Rana chensinensis*, hand of male, to show type of nuptial pad in wood-frogs.
Fig. 10. *Rana chensinensis*, hand of female.
Fig. 11. *Rana montivaga*, hand and arm of male, to show nuptial pad and slightly better-developed arm.
Fig. 12. *Rana montivaga*, hand and arm of female.
Fig. 13. *Polypedates omeimontis*, hand of male, to show nuptial pads.
Fig. 14. *Polypedates omeimontis*, hand of female.
Fig. 15. *Kaloula verrucosa*, foot of male, to show better-developed web.

Fig. 16. *Kaloula verrucosa,* foot of female.
Fig. 17. *Kaloula rugifera,* foot of female.
Fig. 18. *Kaloula rugifera,* foot of male, to show fully developed web.

PLATE X

Fig. 1. *Aelurophryne mammata,* ventral view of male, to show nuptial asperities on fingers and breast, strong arms, and looseness of skin.
Fig. 2. *Aelurophryne mammata,* ventral view of female.
Fig. 3. *Ooeidozyga lima,* ventral view of male, to show median subgular vocal sac with V-shaped ridge of skin.
Fig. 4. *Ooeidozyga lima,* ventral view of female.
Fig. 5. *Hyla chinensis,* ventral view of male, to show external median subgular vocal sac with loose skin.
Fig. 6. *Hyla chinensis,* ventral view of female.
Fig. 7. *Rana phrynoides,* ventral view of male, to show nuptial asperities, spines on breast, and strongly developed arms.
Fig. 8. *Rana phrynoides,* ventral view of female, to show abnormal development of nuptial asperities on prepollex.
Fig. 9. *Rana spinosa,* ventral view of male, to show nuptial asperities and spines on breast.
Fig. 10. *Rana spinosa,* ventral view of female.
Fig. 11. *Rana graminea,* ventral view of female.
Fig. 12. *Rana graminea,* ventral view of male, to show external paired subgular vocal sacs and nuptial pad on first finger.

PLATE XI

Fig. 1. *Rana kuhlii,* ventral view of male, to show large head and loose skin on throat.
Fig. 2. *Rana kuhlii,* ventral view of female, to show short and pointed head.
Fig. 3. *Rana limnocharis,* ventral view of male, to show loose skin on vocal sac.
Fig. 4. *Rana limnocharis,* ventral view of female.
Fig. 5. *Rana macrodactyla,* ventral view of female.
Fig. 6. *Rana macrodactyla,* ventral view of male, to show snout gland or very much pointed snout of male.
Fig. 7. *Rana spinulosa,* lateral view of female.
Fig. 8. *Rana spinulosa,* lateral view of male, to show gland on shoulder region.
Fig. 9. *Rana guentheri,* lateral view of male, to show kidney-shaped shoulder gland and vocal sacs.
Fig. 10. *Rana guentheri,* lateral view of female.
Fig. 11. *Rana n. nigromaculata,* lateral view of male, to show external lateral vocal sac.
Fig. 12. *Rana n. nigromaculata,* lateral view of female.
Fig. 13. *Rana taipehensis,* lateral view of male, to show large tympanum.
Fig. 14. *Rana taipehensis,* lateral view of female.
Fig. 15. *Rana pleuraden,* lateral view of male, to show lateral gland back of arm and vocal sac.
Fig. 16. *Rana pleuraden,* lateral view of female.

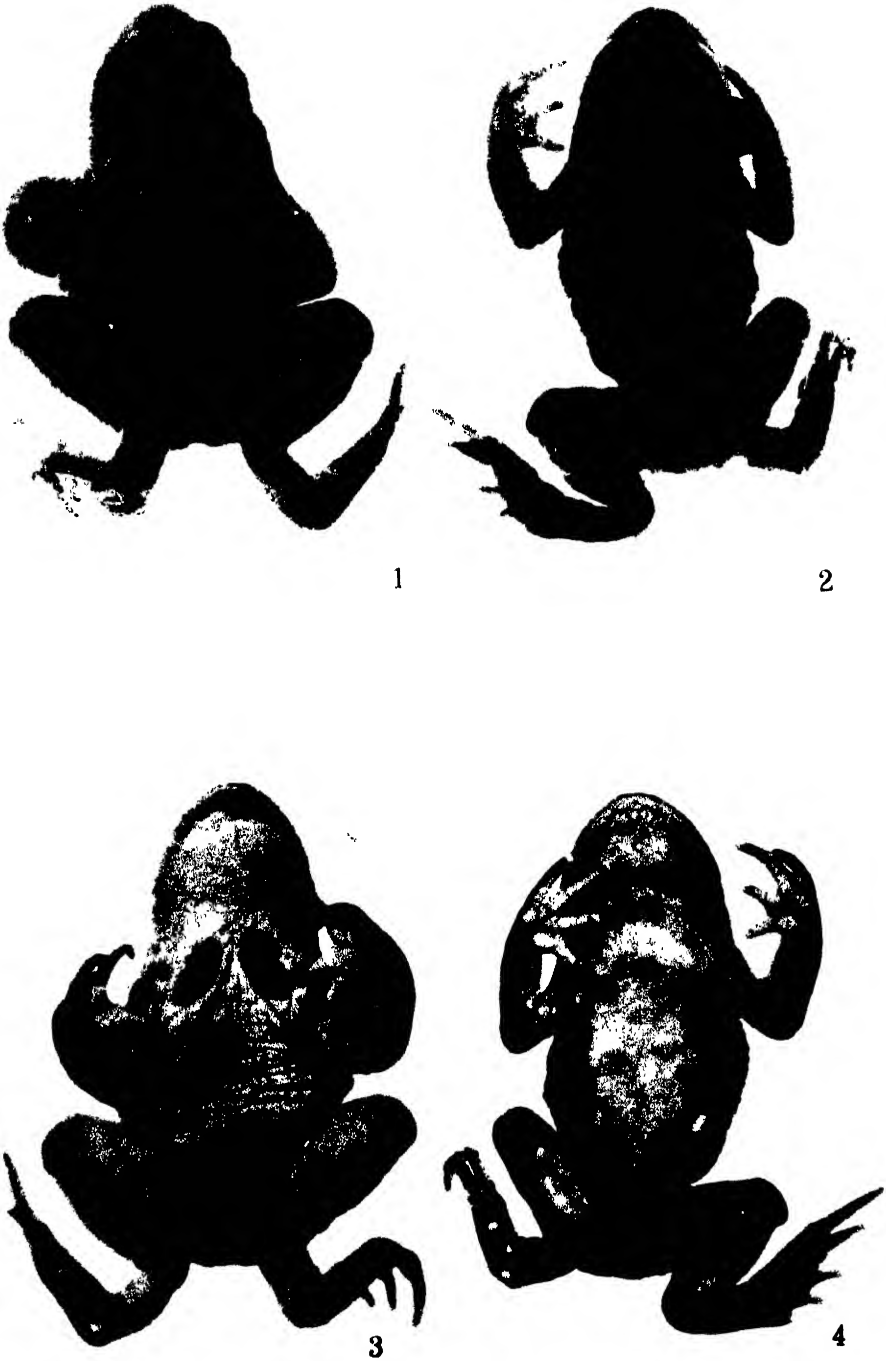
PLATE XII

Fig. 1. *Microhyla heymonsi,* ventral view of male, to show external median subgular vocal sac, dark throat, and fold between bases of arms.
Fig. 2. *Microhyla heymonsi,* ventral view of female.

Fig. 3. *Polypedates oxycephalus*, ventral view of male, to show pointed snout.
Fig. 4. *Polypedates oxycephalus*, ventral view of female.
Fig. 5. *Kaloula borealis*, ventral view of male, to show U-shaped ventral gland.
Fig. 6. *Kaloula borealis*, ventral view of female.
Fig. 7. *Kaloula verrucosa*, ventral view of male, to show ventral gland.
Fig. 8. *Kaloula verrucosa*, ventral view of female.
Fig. 9. *Kaloula rugifera*, ventral view of male, to show ventral gland.
Fig. 10. *Kaloula rugifera*, ventral view of female.

MALES AND FEMALES OF CHINESE FROGS

Bombina orientalis and *Bombina maxima*

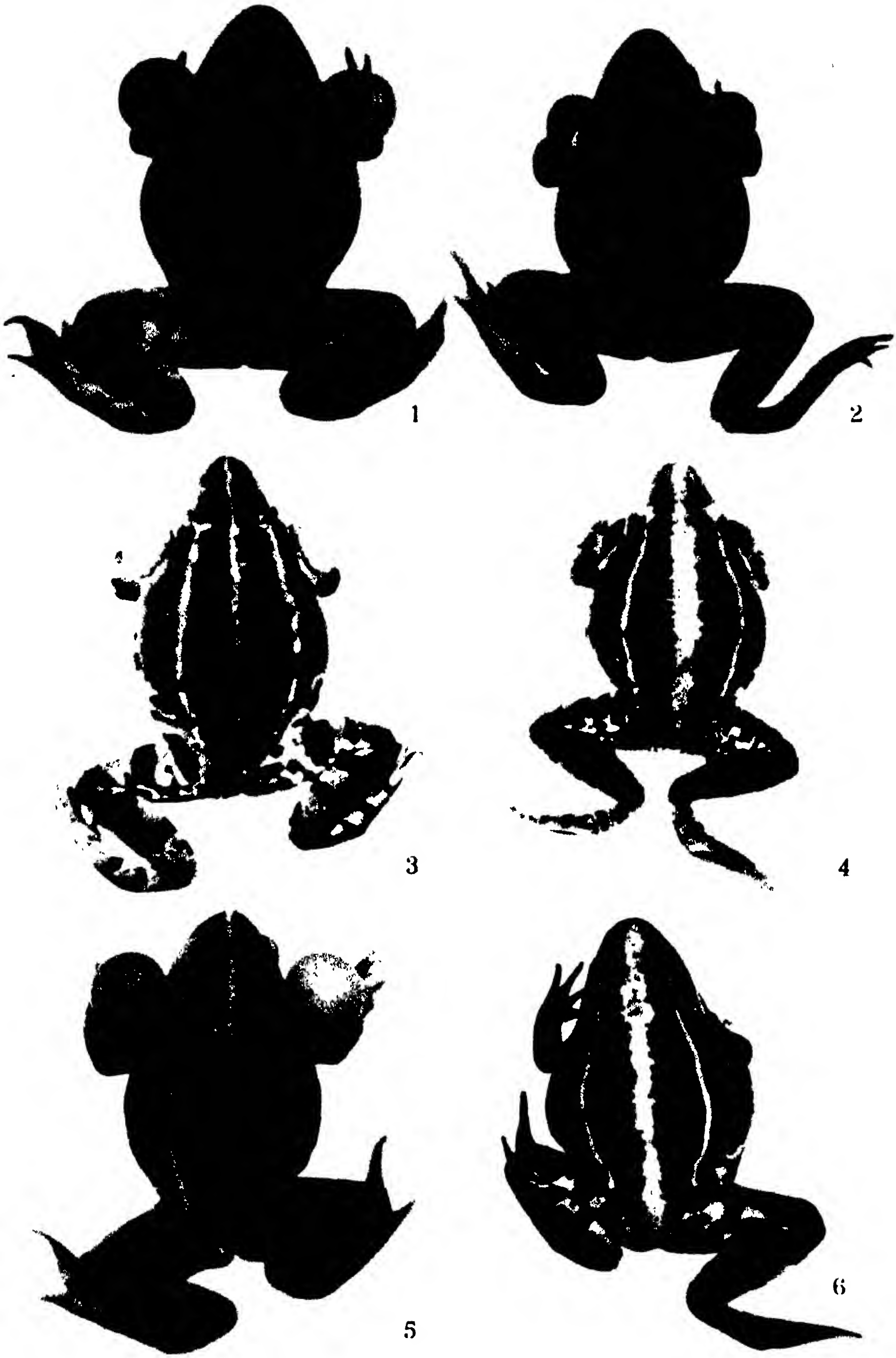


MALES AND FEMALES OF A CHINESE FROG

Aelurophryne mammata

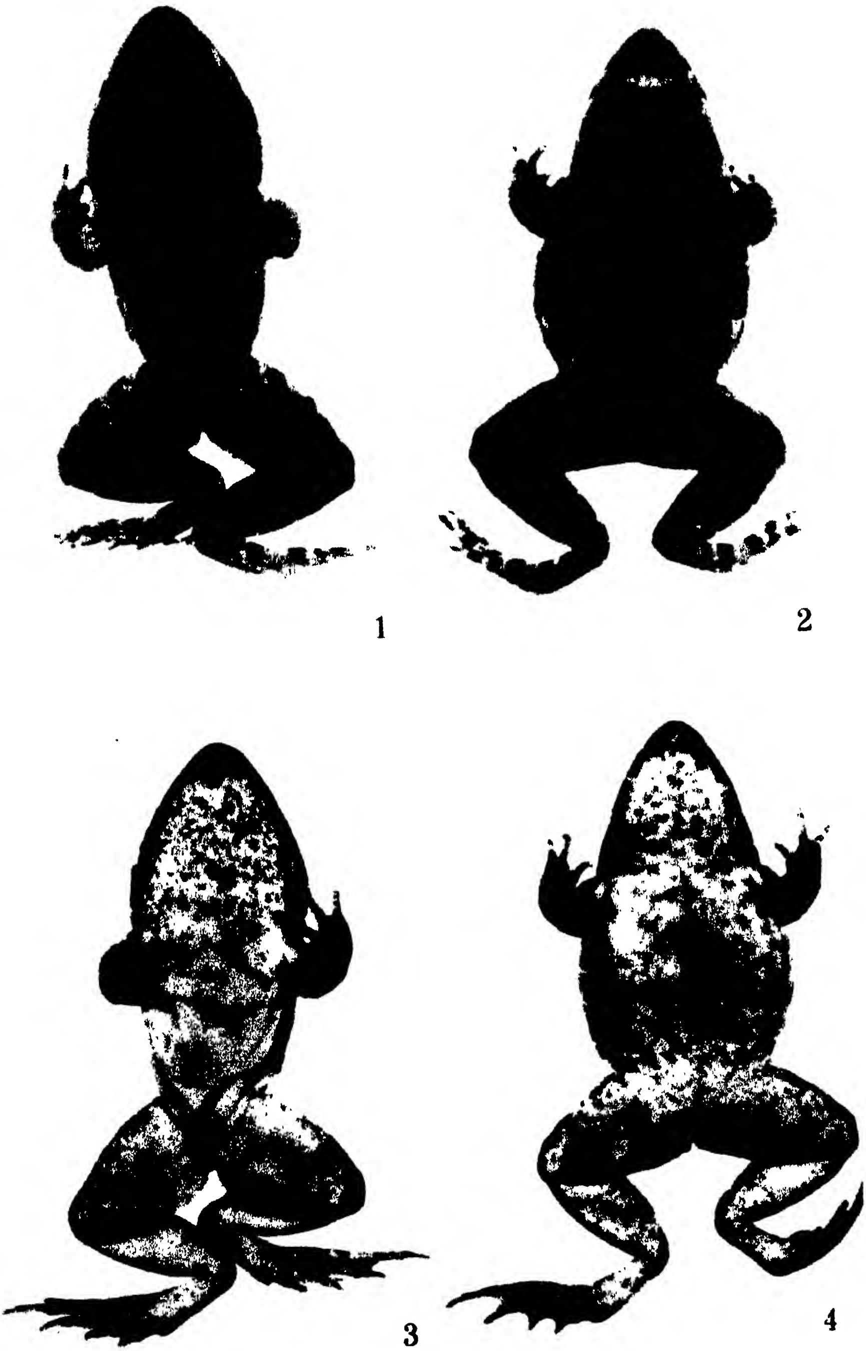
COLORATION OF SEXES IN A CHINESE TOAD

Bufo raddei



COLORATION OF SEXES IN A CHINESE FROG

Rana nigromaculata nigromaculata

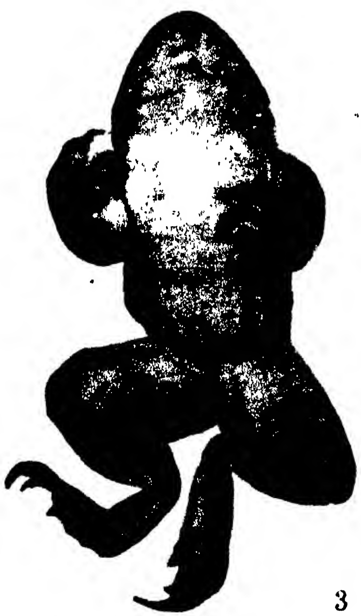


MALES AND FEMALES OF A CHINESE FROG

Rana kuhlii

1

2



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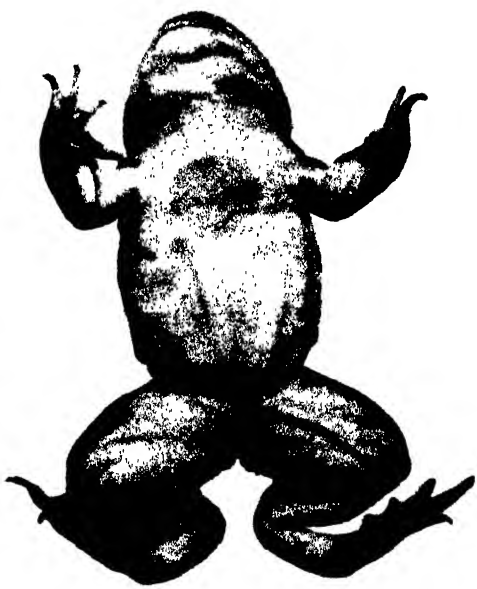

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MALES AND FEMALES OF CHINESE FROGS

Rana spinosa and *Rana phrynoides*

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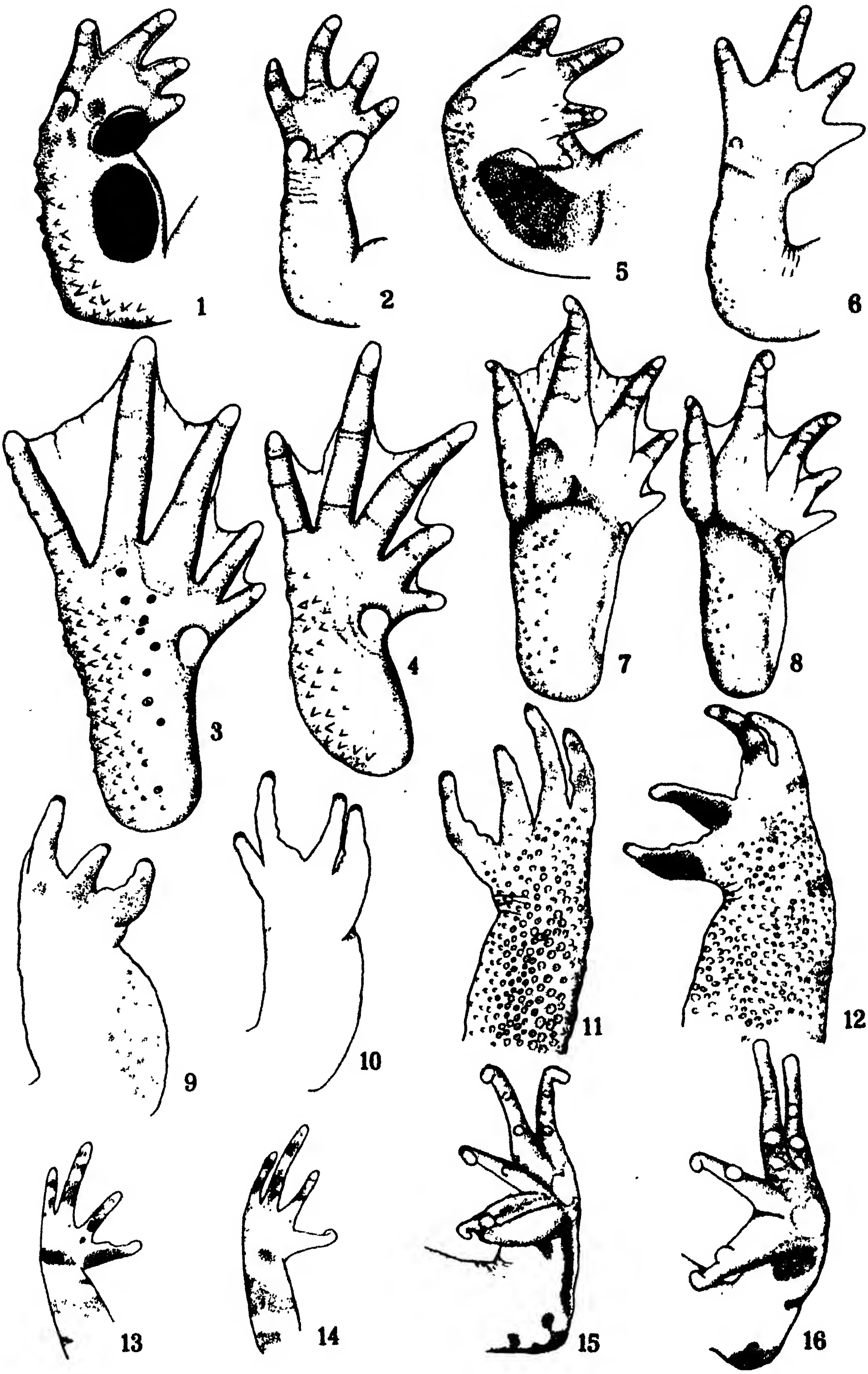
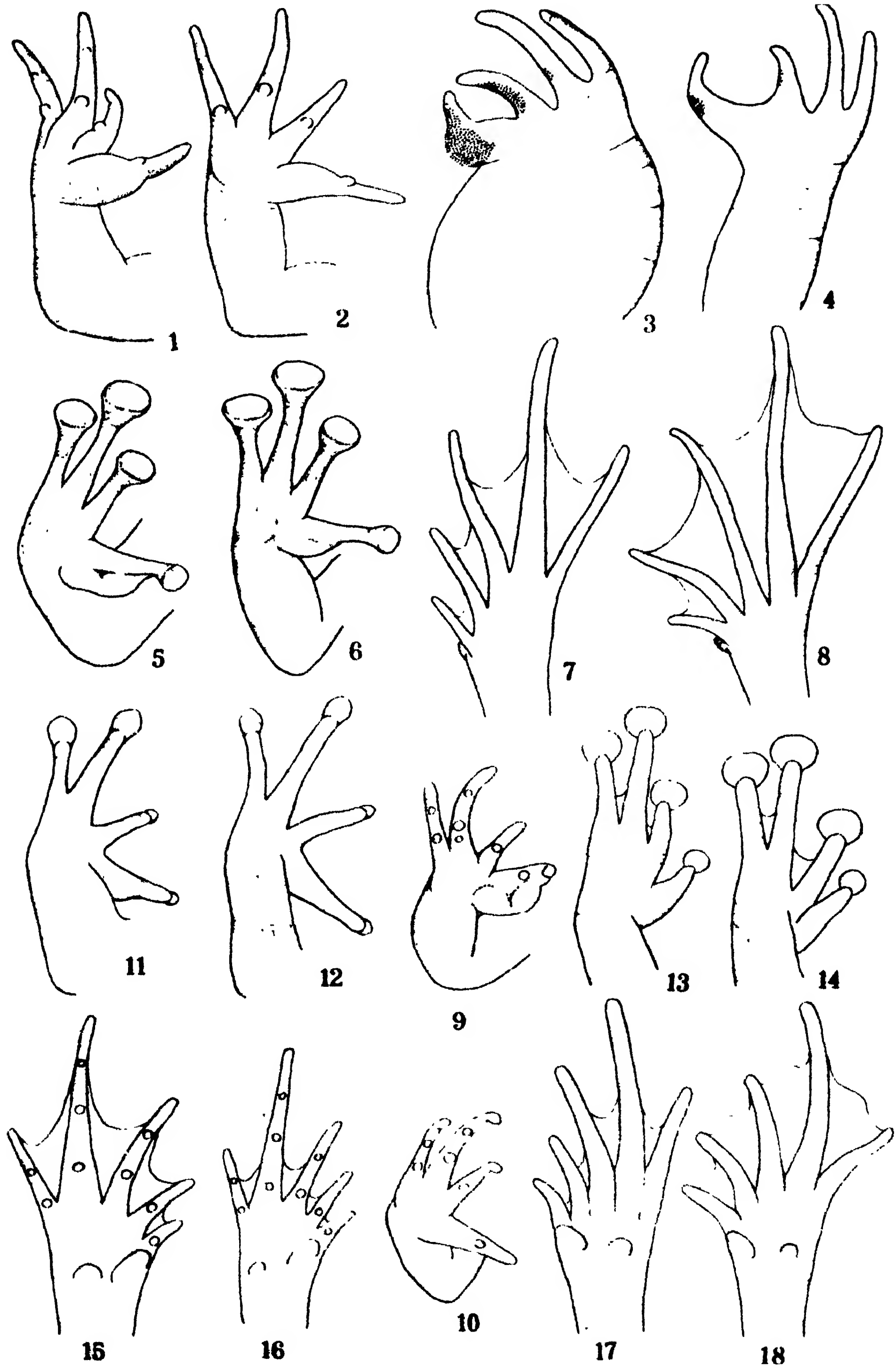
MALES AND FEMALES OF A CHINESE FROG

Polypedates dennysi



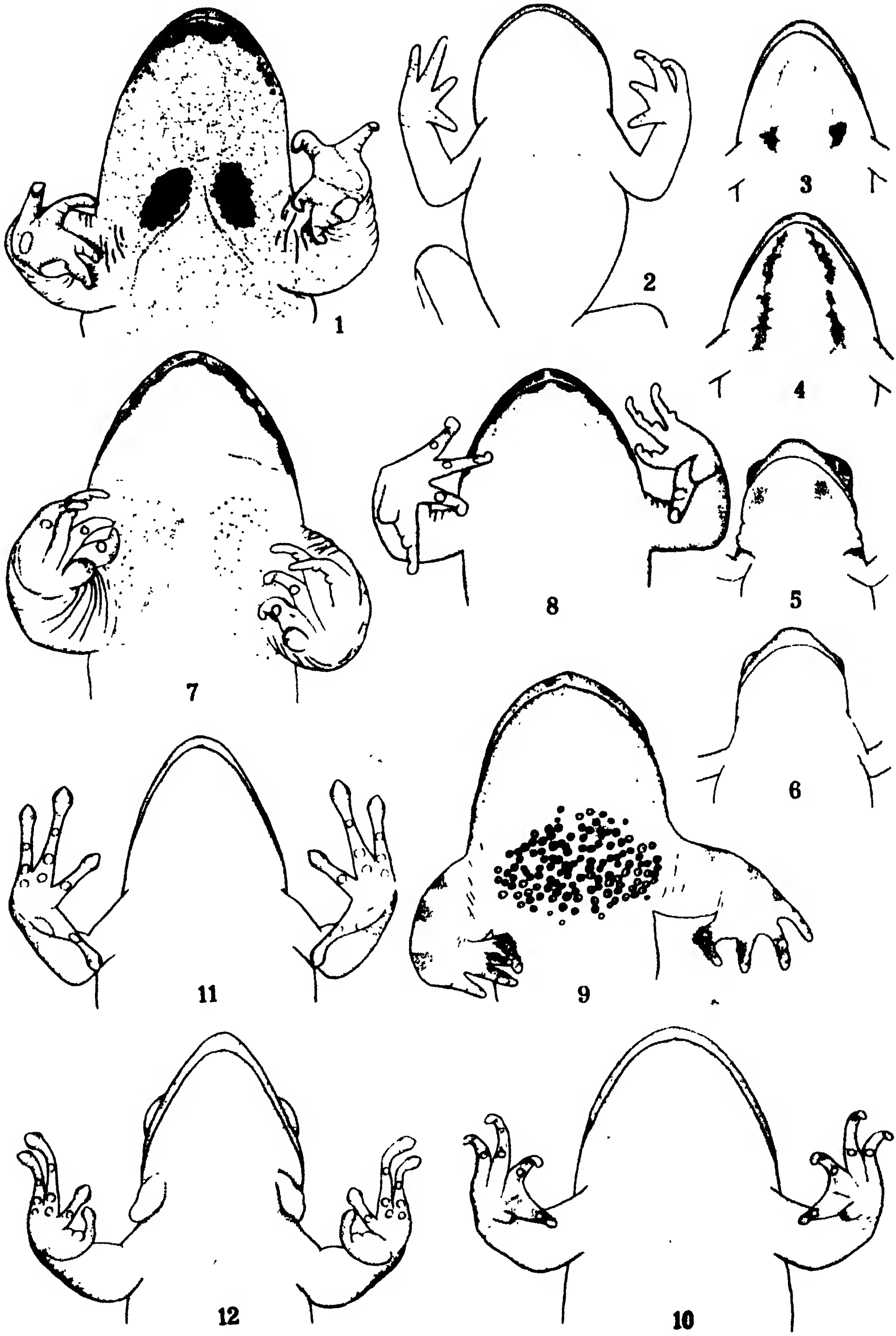
SEX CHARACTERS IN CHINESE FROGS AND TOADS

Bombina, *Bufo*, *Megophrys*, and *Rana*



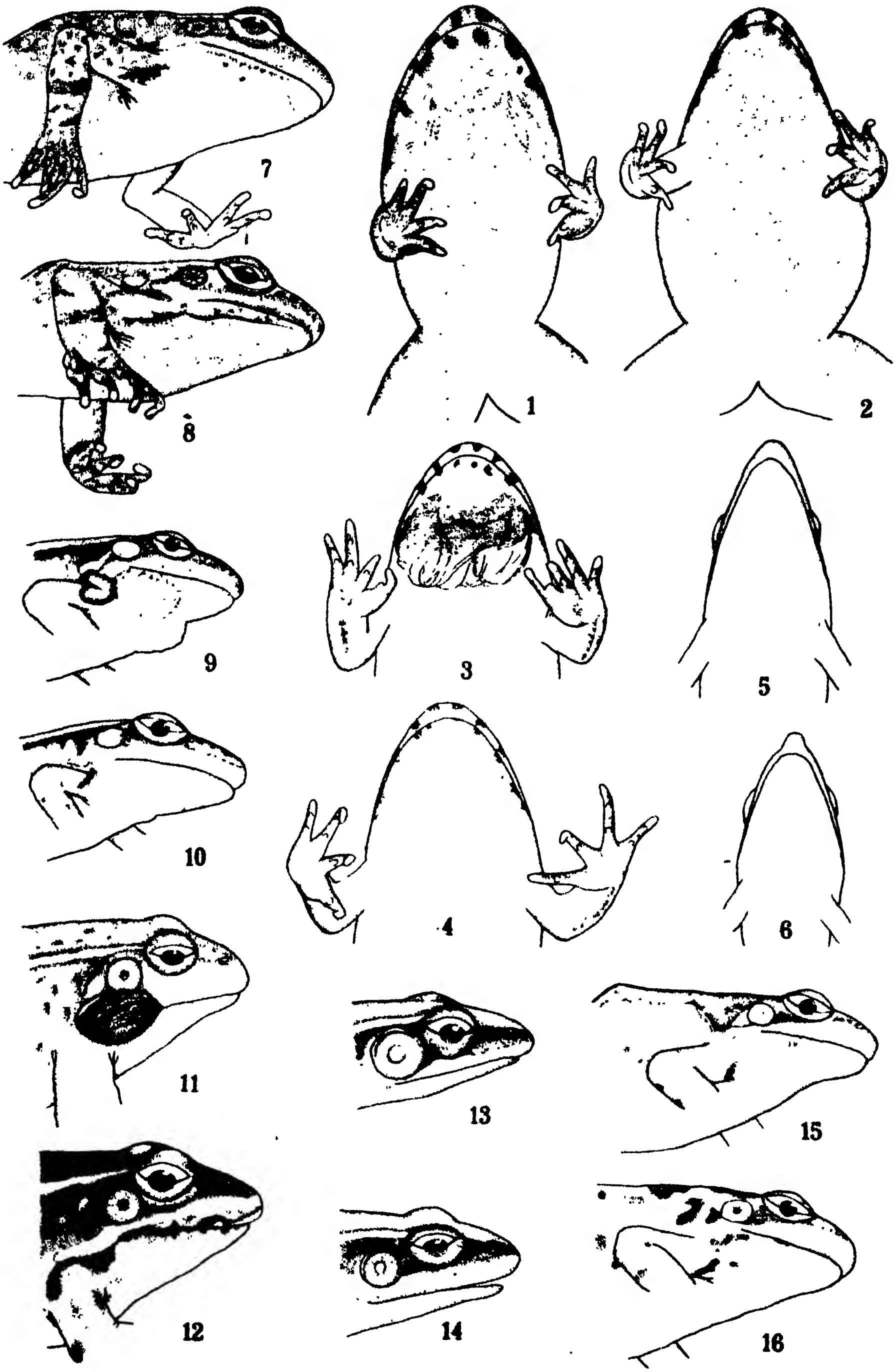
SEX CHARACTERS IN CHINESE FROGS

Rana, Staurois, Polypedates, and *Kaloula*



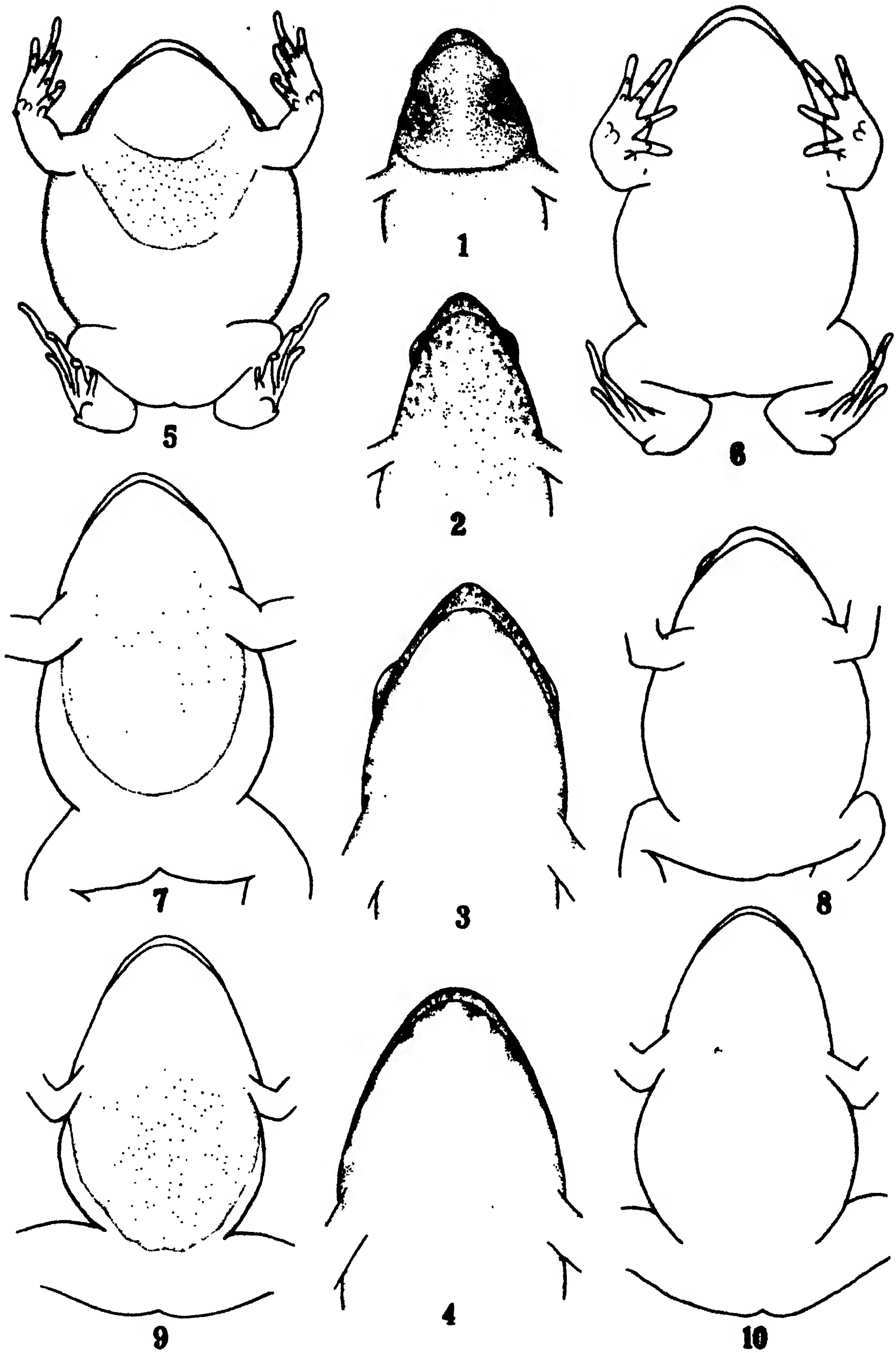
SEX CHARACTERS IN CHINESE FROGS

Aelurophryne, Oocidozyga, Hyla, and *Rana*



SEX CHARACTERS IN CHINESE FROGS

Rana



SEX CHARACTERS IN CHINESE FROGS

Microhyla, *Polypedates*, and *Kaloula*

GENERAL FUNCTION OF THE GALL BLADDER FROM THE EVOLUTIONARY STANDPOINT

BY

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GENERAL FUNCTION OF THE GALL BLADDER FROM THE EVOLUTIONARY STANDPOINT

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It has long been known to anatomists that certain animals do not possess a gall bladder. The evidence offered has usually been from individual dissections, and the explanations of the absence have been rather unsatisfactory. Therefore, an effort has been made to accumulate from the literature and dissections[1] a list of species in which the state of the organ is known. From this list certain physiological conclusions can be drawn.

This work was stimulated by the physiological investigations of Schmidt and Ivy (1937) who studied domestic and wild animals, some with, others without, a gall bladder. They found that animals varied in the amount of bile produced by the liver, the size and concentrating ability of the gall bladder, the motility of the common duct, and the resistance offered by the choledochoduodenal junction to the flow of bile into the intestine. From their data, they concluded that animals without a gall bladder produce large quantities of bile, while those with a gall bladder which concentrates well, produce small quantities of bile. Between these extremes lies a series of intermediate types, and, in general, it may be said that the amount of bile formed by the liver varies inversely with the efficiency of the concentrating apparatus associated with the biliary ducts. These observations suggested that by ascertaining the presence or absence of the gall bladder throughout the various vertebrate orders, evolutionary evidence might be obtained pertaining to the function of the organ. Also, information would become available, serving to further physiological and possibly genetic research.

PHYSIOLOGICAL EVIDENCE

To indicate the academic and practical significance of this problem, an outline of the physiology of the organ will be given.

General Functions Assigned to the Gall Bladder.—The general functions theoretically assigned to the gall bladder are those of serving (*a*) as a bile reservoir for digestive purposes, and (*b*) as a pressure

[1]Field Museum of Natural History has been most generous in allowing the authors to use its collections and libraries. Without the aid of its staff members, this work could scarcely have been begun. We desire to express our thanks especially to Dr. Wilfred H. Osgood, Mr. Colin C. Sanborn, Mr. Karl P. Schmidt, and Mr. Rudyerd Boulton.

regulatory mechanism. These functions are suggested by the following evidence: (1) A sphincter is present at the junction of the common bile duct with the duodenum, and this sphincter is necessary for filling the gall bladder. When the sphincter is relaxed the gall bladder does not fill. (2) In some animals the secretory pressure of bile is markedly less than the pressure necessary to overcome the sphincter. To prevent injurious back pressure on the liver when the sphincter is forcefully contracted, a regulatory device is essential. (3) Cholecystectomy in animals that have a relatively powerful sphincter, leads in most instances to dilation of the common ducts. (4) Those animals which do not possess a gall bladder, physiologically have no sphincter or only a very weak one. Thus, when the gall bladder is present, a sphincter (Sphincter of Oddi; *Sphincter ductus choledocus*) is essential for its filling; and when an efficient sphincter is present a gall bladder is necessary for the regulation of biliary pressure. It is evident, however, that these observed facts bear more directly on pressure regulatory function than on that of bile storage for digestive purposes.

Concentrating Activity of the Gall Bladder.—In some animals, as man, the dog, and the cat, the storage function of the gall bladder is augmented by its ability to concentrate hepatic bile from five to ten times. In such animals, the gall bladder is literally a reservoir itself, of small volume but of large concentrating capacity. In other animals, as cattle, the gall bladder concentrates bile only twice or less. This ability of the organ to concentrate may be interpreted as supporting either or both of the aforementioned functions.

Volume Output of Bile by the Liver.—Animals vary widely in regard to the amount of bile secreted per kilo of body weight or per gram of liver. For example, the guinea pig secretes from 154 to 220 cc. of bile per kilo of body weight per day. Man, however, only secretes 20 cc. of bile per kilo per day.

Physiologic Capacity of the Gall Bladder.—Since the size of the gall bladder, the bile output, and the ability of the gall bladder to concentrate varies in different animals, the physiologic capacity will vary. By this term is meant that fraction of the daily output of bile which the gall bladder is capable of storing. If it were known with certainty that this bile was stored for digestive purposes, this should be a part of the definition. A contrast in physiologic capacity is demonstrated by man, who can store the bile secreted during 12 hours, and a guinea pig, which can store only the bile secreted for 12 minutes.

An Additional Function of the Sphincter.—It should be considered that this structure probably prevents the regurgitation of duodenal contents into the common bile duct. This prevents ascending infection of the liver. It suggests that animals devoid of a competent sphincter should have some compensatory mechanism. Several such mechanisms do occur. There may be a one-way valve; large quantities of bile may keep the ducts flushed out; or the extra-hepatic ducts may show peristaltic activity. Investigations show that the horse, which lacks both a competent sphincter and a gall bladder, has both a valve and a liver, which forms large quantities of bile. On the other hand, the adult pigeon,[1] which also lacks a gall bladder, has motile ducts, and a liver forming large quantities of bile.

Practical Significance of the Problem.—It is not generally agreed that the gall bladder serves for the storage of bile for digestive purposes. This is because physiological studies have not as yet demonstrated detectable disturbances of digestion or nutrition after cholecystectomy. However, when a gall bladder which concentrates efficiently is removed, certain changes are known to occur. These are (*a*) incompetence of the Sphincter of Oddi, with a variable return of competence; (*b*) dilation of the extra-hepatic ducts; (*c*) small areas of local necrosis in the liver. These changes certainly indicate that the gall bladder has a function, even if its general role is not to store bile for digestive purposes. Unfortunately, it is not known why all these changes occur, but dilation of the ducts is generally attributed to the return of competence of the sphincter. If this interpretation is correct, and if no direct digestive disturbances result from cholecystectomy, then the chief function of the organ in man, the dog, and the cat, for example, is to regulate the pressure in the extra-hepatic ducts, and this regulation is rendered necessary by the Sphincter of Oddi. Hence, from an evolutionary viewpoint, a gall bladder was developed secondarily to the sphincter, and the sphincter served primarily to prevent regurgitation from the intestine. However, given an animal whose liver produces relatively small quantities of bile, it is then reasonable to assume that such an animal might possess a better digestive apparatus if a gall bladder and a sphincter were present to render possible the storage of bile for digestive purposes. The following facts force the consideration of such a hypothesis: (*a*) Bile plays an important role in the digestion and absorption of fats; (*b*) it is essential for the absorption of vitamin D and carotene, the precursor of vitamin A; (*c*) it is important in the

[1] A gall bladder is seen in the embryo.

absorption of iron and calcium; (*d*) all domestic animals that form a small quantity of bile have a gall bladder of large physiologic capacity; (*e*) the absorption of bile salts from the intestine augments the secretion of bile by the liver. From this, it seems that a reserve supply of concentrated bile, which may be discharged into the intestine in small amounts during the first 20 or 30 minutes after a meal, would have a favorable effect in initiating digestive processes in the intestine. In fact, the gall bladder bile is sometimes referred to by physiologists as "ignition bile."

If it can be established that the storage of bile for digestive purposes is a function of the gall bladder, it will be obvious that cholecystectomized patients, or patients with chronic disturbances of the biliary tract, should be fed frequently with the idea of promoting the flow of bile by the liver, and thus keep it thin and moving as in animals where there is no gall bladder. That frequent feeding should be employed is an old clinical impression still held by some internists, but such management will not generally be recognized as essential until its physiologic importance is proved. For example, formerly it was debated whether fats and acid fruits should be avoided by the patient with acute cholecystitis. Now, since it is known that fats and acids are potent excitants of gall bladder activity, doubt no longer exists.

In summary, the physiological evidence indicates that the chief function of the gall bladder is pressure regulation; but the possibility that storage of bile for digestive purposes also occurs in those forms which concentrate bile, is one which cannot be easily dismissed. While this remains unproved, it may be surmised that the gall bladder developed secondarily to the appearance of a sphincter at the junction of the common duct with the intestine.

ANATOMICAL EVIDENCE

Bearing the physiology of the gall bladder well in mind, it should be interesting to examine various vertebrate groups for the organ, to ascertain its presence or absence, and to correlate other facts pertaining to the economy of the animal. Thus, diet, other modifications of the digestive tract, and even taxonomic relationships, may bear on the existence of the organ in an individual species.

Little effort has been made to describe variations in the form or anatomical relationships of the organ. Suffice it to say that this hardly seems necessary, since the organ is either present or absent, and no series between the extremes can be easily demonstrated.

"PREVERTEBRATES."—Among lower forms, the liver has not consolidated and migrated to become an organ distinct from the gut. In *Balanoglossus*, the liver is represented by structures called "hepatic caeca," which are groups of cells surrounding numerous ductlike processes which connect with the alimentary tract. In the sea-squirts (ascidians), a group of glands communicates with the stomach by a duct. This is referred to as the digestive gland or liver. In *Amphioxus* the liver is similar. It is thus seen that none of the known predecessors of higher vertebrates possess an organ resembling a gall bladder. The gall bladder then becomes a typical vertebrate structure and very characteristic of the group.

CYCLOSTOMATA.—These are among the simplest vertebrates, but differ from all the others in lacking true jaws. The hagfish (*Myxine*) and the lamprey (*Petromyzon*) both have a gall bladder at some time during their lives. The adult hagfish has a bilobed liver, a gall bladder, but no discrete pancreas. The lamprey has a similar liver and gall bladder in the larval form, but the organ and its ducts are absent in the adult.

FISHES.—Recent fishes are divisible into six orders. Two of these, the sharks and rays (Elasmobranchii), and the chimaeras (Holocephali) have cartilaginous skeletons. The others have true bony skeletons. They are the sturgeon-like fishes (Chondrostei); forms related to the dogfish (Holostei); the true bony fishes (Teleostei); and the lungfishes (Dipnoi). The sharks and rays are representatives of a relatively primitive group which prospered during Devonian times. They all apparently possess a gall bladder.[1] The lungfishes are interesting in that they represent a group similar to that from which Amphibia arose. They, too, retain the organ. The teleosts are the most successful of recent fishes and have been dominant since Cretaceous times. In them the gall bladder is occasionally absent and neither Cuvier (1835) nor Owen (1846) could offer any explanation for the variability. In those fish (Bullheads) which have been studied, the gall bladder was found to contract and evacuate on the administration of fatty foods, but its concentrating ability is not known.

AMPHIBIA.—These all have a gall bladder in so far as they have been examined. This general statement is only superficially attested in the present work (Table 1). From the amphibians of the Coal Measures arose the reptiles which flourished during the Mesozoic,

[1] J. F. Daniel: The Elasmobranch Fishes. Univ. Calif. Press, 1922, p. 139.

and which gave origin during this period to the first mammals. Reptiles, therefore, are of current interest.

Reptiles.—All existing forms possess a gall bladder. Early workers reported its occasional absence, but their information was apparently erroneous. In Table 2 the presence of the organ is recorded in 42 families and 70 species. An attempt is made in this, as in subsequent lists, to select genera characteristic of their respective families.

It is perhaps unfortunate that no recent reptile approximates those from which mammals arose. But it is probable that these and, in fact, all reptiles possessed gall bladders. Therefore it is reasonable to believe that all early mammals likewise had the organ.

The habit of intermittent feeding in reptiles is well known. Some of them are carnivorous and others herbivorous. These habits support the suggestion that the gall bladder is a reservoir of bile for digestive purposes. However, nothing is known concerning the physiology of the organ in this group.

Birds.—This group appears to have been evolved from reptiles at about the same time as mammals, but it has attained a high degree of specialization and the number of the existing species is very large.

With the available information, conclusions are difficult. Tendencies are perceptible, however. The carnivorous birds (hawks, owls, etc.) all retain the organ, while the herbivorous forms (parrots, pigeons) and the insectivorous forms (woodpeckers) may retain it or lose it. In no order yet examined is the organ invariably absent. It has been suggested (by R. Boulton, of Field Museum staff) that the insectivorous birds which have lost the organ were immediately derived from an old herbivorous ancestry. An example of interest here is the Kea parrot of New Zealand, whose carnivorous habits are as recent as the introduction of sheep into that region.

The list of species in Table 3 is given as a matter of record, with the hope that its evident deficiencies will stimulate investigation by those who have more available material.

Mammals.—In this paper, mammals are of prime interest. This is largely because of man, and because it is more logical to correlate the physiology of man with that of other mammals than with that of some lower group. The orders will be considered separately.

Monotremata.—The monotremes are in many respects the most primitive of living mammals, yet in some respects they are highly

specialized. It seems not unlikely that they represent a line which descended directly, but independently, from the mammal-like reptiles. It may be recalled that they have a bill or beak devoid of teeth, and that they lay eggs but nourish their young on milk.

The spiny anteater (*Echidna*) and the duck-bill (*Ornithorhynchus*) differ in their habits. One is terrestrial, and the other is semi-aquatic; one feeds on insects, and the other on shellfish and mollusks. Both have a gall bladder, and the cystic duct and the pancreatic duct join the common duct before it enters the intestine. Nothing is known concerning the physiology of the gall bladder or bile ducts.

Marsupialia.—Marsupials are considered higher than monotremes because they have abandoned the oviparous method of reproduction and now bring forth very immature young which are nursed in the marsupium, a structure characteristic of this group. The American opossum is a simple form which represents an ideal ancestor which has apparently passed almost unchanged from Cretaceous times. At the end of the Cretaceous, placentals began to appear and later became dominant. Somewhat previous to this, Australia with her mammalian fauna became isolated. With no other competition, marsupials there radiated adaptively until almost every ecologic niche was filled. Thus, we have marsupial forms which parallel superficially almost every other mammalian type.

Food habits vary widely. The opossums (Didelphiidae) are essentially omnivorous. Forms like the Tasmanian wolf (Dasyuridae) are usually carnivorous, but other members of the family are insectivorous. The marsupial mole (*Notoryctes*) represents a monotypic family (Notoryctidae) which is insectivorous. Species allied to the Koala (Phascolarctidae) are herbivorous and the honey-bear, itself, eats only the young shoots of a single species of Eucalyptus. The wombats (Wombatidae) are herbivorous. The kangaroos and wallabies (Macropodidae) are herbivorous, and the large kangaroo is said to practice a kind of rumination. The interesting American marsupial, *Caenolestes* (Caenolestidae), is insectivorous with an omnivorous tendency. The anteater, *Myrmecobius*, is the lone representative of its family (Myrmecobiidae).

As might be expected, the stomach of marsupials shows adaptations related to the diet. The stomach is simple in the zoophagous, entomophagous, and carpophagous forms. In those types which feed on the bulkier parts of plants, the stomach becomes complex. The gall bladder is present in all marsupials (Table 5) and is of large

size, with no tendency to reduction in volume. Nothing is known concerning its concentrating ability. It contracts weakly, but the ducts and extraduodenal ampulla of the common duct are motile.

The fact that all marsupials possess a gall bladder, even those which are strictly herbivorous, is of great interest. Among placental mammals, where the herbivorous type of diet has been assumed, the organ is absent in certain species. Remembering that marsupials are rather low in the scale of mammalian evolution, it would seem that the gall bladder is a primitive structure not easily lost.

Table 5 affirms the presence of the organ in 26 species, representing the 10 existing families.

Most living mammals belong to a more advanced group known as the placentals, in which a true placenta is constantly found. This structure permits a longer pre-natal period, and the need for the marsupial pouch is consequently lost. Other marked differences occur.

Primitive placentals are known to have existed at the end of the Age of Reptiles. These primitive placentals were insectivorous, and from them arose the ancestors of our existing higher mammalian fauna. Members referable to the same order (Insectivora) as some of the early forms, still exist.

Insectivora.—Table 6 records the existence of the gall bladder in 34 species, representing all families. The name of the order implies the nature of the diet, but a number of species eat fresh flesh when it is offered.

Chiroptera.—Rather closely related to the insectivores, but of ancient and unknown origin are the bats. Bats have been very successful, and many families and species exist. They fall into two suborders, the Megachiroptera being the more primitive. The majority of these are large, and subsist on fruit and pollen. The stomach is rather complex. Most of the Microchiroptera are small and more highly specialized. The construction of the stomach differs according to the diet, which includes all types. Some 17 families and about 2,000 different species and subspecies of bats are said to exist. Table 8 records the gall bladder present in 13 families and 59 species. Therefore it is very probable that it is present in all bats.

Dermoptera.—This order is represented by a single living genus, *Galeopithecus* (or *Galeopterus*). This animal, known as the flying lemur, is interesting, as it represents a form possibly similar to the

progenitors of bats. It is a fair-sized, herbivorous, tree-living form with a moderately complex stomach. The gall bladder is present (Table 7).

Primates.—Paleontologically and structurally, the primates are closely related to the primitive arboreal insectivores, the chief advances having been made in the development of a large brain, and stereoscopic vision. Three suborders are distinguishable. These are represented by the lemurs (Lemuroidea), by *Tarsius* (Tarsoidea), and by the true monkeys and apes (Anthropoidea). The lemurs

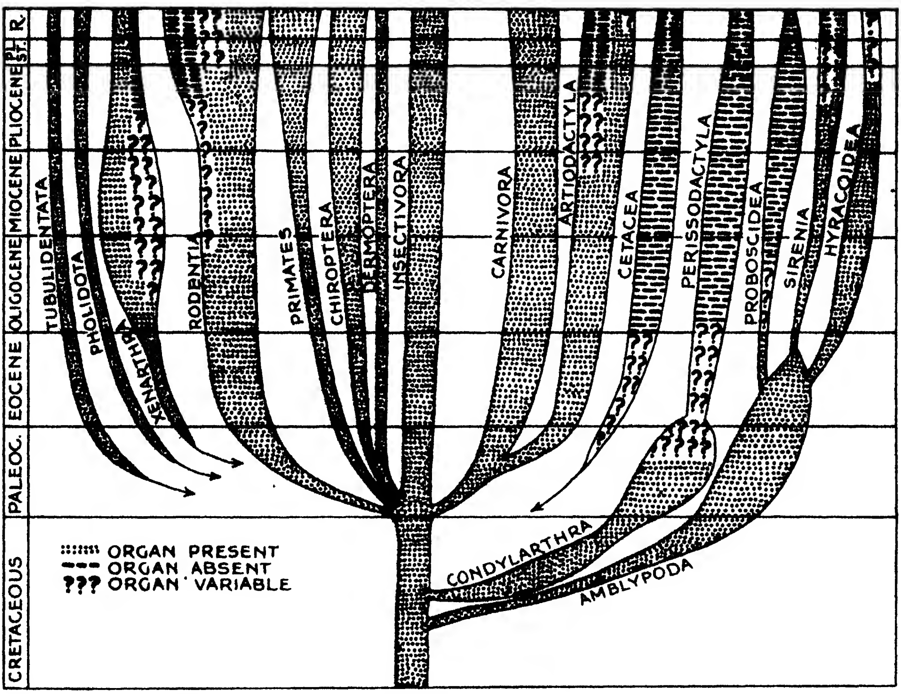

FIG. 1.. Probable history of the gall bladder in placental mammals (adapted from Romer).

are the most primitive of living primates, and they possess many insectivore affinities. Between the lemurs and the true monkeys is *Tarsius*, possessing some of the features of each group. The anthropoids include monkeys, apes, and man. They are separable into the New World forms (Platyrrhines) and the Old World forms (Catarrhines). The latter include the family Hominidae, of which man is the only member.

The diet of primates is quite varied. As a group they are omnivorous. The more strictly herbivorous forms subsist chiefly on the more concentrated portions of plants, such as the seeds or

fruit. The stomach of the lemurs and of *Tarsius* is simple. In the New World monkeys the stomach is simple except in the spider monkeys (*Ateles*), and the howlers (*Alouatta*), where there is some tendency to sacculation. In the Old World monkeys, the stomach is simple in the species which possess cheek pouches. In the langurs (*Presbytis*) and the guerezas (*Colobus*), which have no cheek pouches, the stomach is complex. In these monkeys, there is accumulation and retention of vegetable food in the stomach, and bezoars are not rarely found. The stomach reaches its maximum complexity in this group, which includes the sacred ape of India, one of the langurs.

The gall bladder is present in representatives of all families of primates. Table 9 includes 68 species.

Carnivora.—Fossil evidence indicates clearly that all terrestrial fissiped carnivores arose from one creodont family (Miacidae) probably since Eocene times. Eocene and Paleocene carnivores were known as creodonts and are directly descended from primitive insectivores of the preceding era. The ancestry of the marine forms is not known but is probably very similar. From the direct ancestry, diet, and feeding habits, these forms would be expected to possess constantly a gall bladder and this is well shown in Table 10 where 65 species representing all families were found to have the organ.

Edentates.—Under the general term "edentates" convenience may allow an inclusive discussion of three unique mammalian orders, the Xenarthra, Pholidota, and Tubulidentata. Linnaeus, Cuvier, and other early investigators noted the queer dental structure and the lack of relationships with other orders, and therefore placed all these together in a distinct but somewhat heterogeneous order. Careful examination of anatomical and paleontological evidence failed to reveal any true relationships, and separate orders were indicated.

The order Xenarthra includes the armadillos, anteaters, and sloths. Existing species are only a shadow of a previously large and varied fauna. Recent forms are, for the most part, highly specialized. The anteaters subsist mostly on termites; the armadillos are insectivorous but feed frequently on carrion; the sloths are herbivorous. As in other orders, the stomach is adapted to the diet. A gizzard-like pylorus occurs in the insectivorous forms, while the stomach tends to become complex in the sloths. The gall bladder is present in all forms except *Bradypus*, the three-toed sloth. It is significant that variation in this order first appears in the herbivorous types. However, the question immediately arises as to why the organ exists in *Choloepus*, the two-toed sloth. Has this species been long distinct

or has it only recently diverged? The existing limited fauna with its paucity of species speaks against recent divergence and so also do marked structural differences other than the gall bladder. Therefore, Miller's (1923) classification is followed in which *Choloepus* stands as the only genus of a family.

The order Pholidota, containing three genera, is the scaly ant-eater of the Old World. The two genera examined, *Manis* and *Smutsia,* possess a gall bladder and a gizzard-like pyloric antrum.

Orycteropus is the single living representative of the order Tubulidentata. Its relationships are also unknown, but the work of Jepson (1932) suggests that the order was distinct by the end of the Eocene. The pyloric antrum is moderately thickened, and the animal possesses a gall bladder.

The condition of the gall bladder among the Edentates is shown in Table 11.

Artiodactyla.—Existing artiodactyls form three distinct groups: (*a*) Suina: pigs, peccaries, hippopotamuses. (*b*) Tylopoda: camels and llamas. (*c*) Pecora: chevrotains, deer, giraffes, prongbucks, and bovids. These suborders were all separate by the end of the Eocene, but more primitive forms are found earlier in this epoch which give evidence as to the ancestry of the whole group. Matthew (1909) and Gregory (1910) believe that the Artiodactyla have been derived from unknown creodonts allied to the Mesonychidae. These are carnivorous, so it is perhaps correct to say that a cow is more closely related to a lion than it is to a horse.

Among the Suina, the true pigs (Suidae) constantly possess the gall bladder. The peccaries (Tayassuidae) have lost the organ. As to the hippopotamus, the gall bladder was absent in one of the four recorded dissections. More data would be desirable. It is interesting that the pig has a simple stomach, while that of the hippopotamus and the peccary is complex. It has even been suggested that the two latter ruminate.

The Tylopoda, camels and llamas, have long been distinct from other artiodactyls. They have complex stomachs and ruminate. They lack the gall bladder.

All Pecora probably arose from forms similar to existing Traguline deer, the chevrotains, which have a gall bladder. True deer (Cervidae) have probably all lost the organ, with the exception of the musk-deer (*Moschus*). This Asiatic form represents a species which is transitory between the true deer and their Traguline

ancestors. The retention of the gall bladder adds to the evidence afforded by the lack of horns and the excessive development of the canines, which indicates the primitive nature of this deer.

The American prongbuck, not a true antelope, has a long separate history, and is the single living representative of the family Antilocapridae. It has a complex stomach and a gall bladder.

The giraffes (Giraffidae) offer the curious possibility that the organ may be anomalously present in a very small percentage of cases. It has been reported in two of twenty recorded dissections.

The gall bladder is probably present in all members of the family Bovidae, with the exception of those in the subfamily Cephalophinae, a group of small African antelopes known as duikers in which it is constantly absent. The absence of the organ has been made a characteristic of this group by Pocock (1918). Crisp's (1862) report of its absence in two species of the subfamily Bubalinae should be rechecked in view of other errors made by this author. The report of the organ in two closely related groups by Garrod (1877) also needs confirmation. *Tetracerus,* a form which has long been juggled between the Cephalophinae and the Tragelaphinae, should by gall bladder evidence be classed with the latter, as is done by Weber (1927).

In such an early distinct order, which has shown such great radiation and which has claimed so many now extinct genera, diversity of structure in existing species might be expected. The rather uniform presence or absence of the gall bladder in the various families lends significance to the gall bladder as an important structural characteristic. Its occasional appearance in the giraffe and the primitive musk-deer is of interest in connection with their supposed Traguline origin. The retention of the organ in the Antilocapridae and most of the Bovidae lends support to the theory of the rather recent radiation of these families from the Tragulidae. The absence of the organ from the Cephalophinae may indicate a divergence of this subfamily from the Bovidae. At least, the presence or absence of the gall bladder follows quite well the taxonomy of this rather heterogeneous group (Table 12).

"Sub-ungulates."—Three orders of mammals are generally referred to under this name. They are the Hyracoidea, Proboscidea, and the Sirenia. Although existing species show few affinities, the earlier representatives had many similarities which suggest a common origin (Romer, 1936).

The Hyracoidea, known as conies or dassies, have one principal living genus (*Procavia*), confined to the Old World, and including various species. Superficially, they resemble rabbits, but dentition and foot structure unmistakably ally them to hoofed animals. Their stomach is rather complex and Lydekker reports that they ruminate. The Biblical[1] description is fitting: "Cheweth the cud, but divideth not the hoof." Records of dissections of these animals are confusing either because the gall bladder was variable, or the interpretation of the structure found was not uniform. The first explanation is probably correct.

The order Proboscidea includes the elephants. These are highly specialized forms with a rather unique biliary anatomy. The gall bladder is absent but the common duct is wide, long, and has a reticulated mucosa. A large duodenal ampulla, called the terminal bile pouch, is present. It is divided irregularly into sacks and the pancreatic duct enters it. Owen (1866) says it is contractile. The structure is reminiscent of that found in some whales, and of the extra-duodenal ampulla of the guinea pig and opossum.

The order Sirenia includes three recent families, one of which has become extinct in historic times. This last, Steller's sea-cow, apparently is the only one which lacks a gall bladder. This is difficult to explain, but the stomach is very complex.

In animals which have evolved in the direction of these forms, a tendency to disappearance of the gall cyst is perceptible. In the elephants, this tendency is completely manifest; in the sirenia and hyraces it is less so. It seems that the latter are about to lose the organ. There is a pouch in the elephant which seems analogous to structures seen in some whales, but the elephant is a herbivorous type and the need for this compensatory structure is not obvious.

Perissodactyla.—This order, once more abundant, is now represented by horses, tapirs, and rhinoceroses. In many respects, these forms have become highly specialized. It is well to point out that the order is an ancient one, first appearing at the base of the Eocene. When curiosity is expressed concerning the reason why two animals whose habits are as similar as those of the horse and the cow differ in respect to the gall bladder, it should be pointed out that they are of diverse ancestry. Thus, the gall bladder is constantly absent in the Perissodactyla (Table 14),

[1] Leviticus 11:5.

but only occasionally so among the Artiodactyla. The stomach in this order is simple, but the immense size of the caecum is almost characteristic. In the wall of the common duct are some microscopic sacculi which may have compensatory significance. These are found in the horse but not in the tapir.

Cetacea.—Whales are highly specialized marine mammals of very wide distribution. Unlike most other aquatic mammals, they are incapable of any locomotion on land. Structural vestiges, however, indicate that they were not always so confined and paleontologists agree that they were probably derived from terrestrial carnivores some time in the Paleocene. By the end of the Eocene, they constituted a distinct mammalian order. Thus, as were the horses so were the whales, exposed to evolutionary tendencies over a long period.

Table 15 shows that the gall bladder was absent in all except one of the species recorded, and examination of this exception (Williams, 1838) leaves the impression that a mistake might well have been made.

The absence of the gall bladder in the Cetacea is indeed odd, for these forms are highly carnivorous. They have very complex stomachs like ruminants, but the proventriculus is aglandular. The whale-bone whales (Mysticeti) feed on small marine invertebrates like cuttle-fish and squid; the toothed whales (Odontoceti) feed on fish and at least one genus, *Orca*, the killer, feeds on seals. The nature of the whale's diet makes continuous feeding highly improbable. But the complex stomach and the observation that whole food is regurgitated when the animals are harpooned, led Beddard (1900) to suggest that the animals feed hurriedly and store their food in an accessory stomach. The digestion of this food would then be protracted over several hours.

In *Tursiops* (Hein, 1915), and probably a good many other Odontoceti (Weissberg, 1933), a dilated bile reservoir is found in the course of the common duct. Into this drains the pancreatic duct, and between the reservoir and the intestinal outlet the common duct contains a valve similar to the *valvula spiralis* of the human cystic duct. This structure is very interesting and may represent a true compensatory mechanism. Were these animals of herbivorous ancestry, such biliary anatomy might be explained by suggesting that the whale was an animal which lost the gall cyst, changed its habits, and, when the need for the organ reappeared, developed the structure which is described above. With a proven carnivorous ancestry,

however, explanation is difficult, but it may be associated with the complex stomach, or a depth-pressure modification.

Rodentia.—Rodents are known from a long paleontological record, and they were early divisible into two suborders. One, Simplicidentata, has two upper incisors; the other, Duplicidentata, has four. The rabbits and their allies comprise the latter group.

More superficial divisions are quite natural. The squirrel-like forms, Sciuromorpha, are the simplest and the most primitive genera. Radiation at an early era resulted in our present diverse sciuromorph fauna, including six rather distinct families.

Mouselike rodents, Myomorpha, are a more recent offshoot from early rodent lineage. Structural modifications indicate a degree of specialization not seen in the squirrel-like forms. Three families are included among the existing genera. The dormice, Myoxidae, retain a simplicity of structure indicating that forms similar to them may have been ancestral to the more highly specialized Dipodidae and Muridae. The jerboas, Dipodidae, are saltatorial forms of unknown ancestry. However, the greatest number of living rodents are found in the true rats and mice, the Muridae. Excepting man, they are the most successful of recent mammals, and, like man, their terrestrial range is practically unlimited. Radiation was apparently from the Old World.

The other division of simplicidentate rodents, the Hystricomorpha, includes a variety of forms of which the porcupine and the guinea pig are representative. The hystricid rodents are largely confined to South America, on which continent a great multiplicity of species has developed.

The rabbits and hares have been placed in a distinct order (Lagomorpha) by many authorities. The possession of a pair of extra incisors was a differential point in Oligocene times, but morphological similarities probably best find recognition if a single order is used.

Rodents are essentially herbivorous, but a number of them will accept a more omnivorous diet. The families may be considered separately:

Aplodontiidae: These live near mountain streams and in dense vegetation of the Pacific northwest. They feed on various green plants.

Sciuridae: These feed chiefly on nuts, seeds, and grass. They probably occasionally eat birds' eggs and insects.

Castoridae: Beavers are aquatically adapted forms which fell trees. The bark of the trees is utilized for food.

Heteromyidae: Kangaroo rats and mice of the Americas which live abundantly in arid, subdesert regions where plants bloom freely for only a few days during the year. The result is a large number of seeds. These are gathered and stored by the animals for future consumption. Apparently they hibernate.

Geomyidae: Pocket gophers are fossorial and eat roots, bulbs, grass, and seeds. They may feed more or less constantly. They do not hibernate, but tunnel extensively under the snow when necessary.

Pedetidae: These are fossorial and saltatorial forms, the Cape Jumping Hares. Their food seems to be entirely of a vegetable nature.

Myoxidae: Arboreal and nocturnal creatures of small size. They feed on nuts and seeds, and probably hibernate.

Dipodidae: Feed upon buds, leaves, twigs, and many kinds of plants; on seeds, grain, wild berries, chestnuts, acorns, grass, and bark.

Spalacidae: The Cape Mole-rats live in subterranean burrows, which they dig in search for bulbs and roots.

Muridae: This family includes a variety of rats and mice, whose habits were probably originally herbivorous. They easily modify their needs to the available supply. Their diet has in many cases become that of man, whom they parasitize.

Bathyergidae: Members of this group are fossorial and subsist on a vegetable diet.

Hystricidae: Old World porcupines whose food is entirely vegetable and consists mainly of roots.

Erethizontidae: Arboreal forms, which eat the bark of trees. They do not hibernate. They are restricted to the New World.

Dasyproctidae: The agoutis are tropical rodents, whose food consists of foliage, roots of ferns, fallen fruit, and possibly nuts.

Caviidae: The best-known member of this family is the common guinea pig. In their natural state, the cavies feed on roots, corn, and other vegetable substances.

Chinchillidae: Grass and roots form the chief substance of their diet. Long arid seasons may deprive these animals of water for considerable periods, but they seem to survive on the dried grass.

Capromyidae: Arboreal forms which live in the dense forest. Feed on fruits, leaves, and bark, but may also eat the flesh of small animals, particularly that of a kind of lizard.

Octodontidae: The octodonts are represented by both African and South American variations. Both of these are herbivorous.

Thryonomyidae: The African cane-rat which digs for roots and ground nuts. Extensive runway systems are formed under the grass and reeds.

Ctenodactylidae: An African diurnal form. It lives among rocks and is herbivorous.

Leporidae: The rabbits are diurnal and strictly herbivorous.

Ochotonidae: These interesting mammals live in alpine rock slides. They gather grass which they stack and allow to dry. This supply keeps them during the winter months.

It has been impossible to investigate thoroughly all the available rodent material, but a few noteworthy points may be mentioned. The stomachs of rodents vary markedly in their form and even in their histologic structure. This variation has been the subject of at least one paper.[1] Arrangement of rodent families into two groups, one with simple stomachs, and the other with complex stomachs, failed to reveal any correlation with the presence or absence of a gall bladder.

The gall bladder is present in some families, absent in others, and variable in still others (Table 16). Further investigations are desirable and will probably alter these lists:

Present

Castoridae	Spalacidae	Capromyidae
Anomaluridae	Bathyergidae	Thryonomyidae
Myoxidae	Dasyproctidae	Leporidae
Dipodidae	Caviidae	Ochotonidae
	Chinchillidae	

Absent

Aplodontiidae	Heteromyidae	Petromyidae
Geomyidae	Pedetidae	Erethizontidae

Inconstant

Sciuridae	Hystricidae
Muridae	Octodontidae

Conclusions are not accurate with such meager evidence. The whole order seems to be in a rather plastic state. Evolutionary tendencies are perceptible.

The gall bladder is absent in the Aplodontiidae. In the Sciuridae it is usually present. The Pedetidae are intermediate between

[1] K. Toepfer. Die Morphologie des Magens der Rodentia. Morph. Jahrb., 17.

the Sciuromorpha and Myomorpha and, as they are in other respects highly specialized, the gall bladder absence is not surprising. However, the apparently close relationship which these forms have to the Anomaluridae, which are cholecystous, and the variation of the organ in the existing Myoidea, suggest an origin of this latter group from separate forms, some in which the organ was present and others in which it was absent.

The geomyids and heteromyids are closely related and have been distinct since Oligocene times.

Among the Myomorpha, the Myoxidae, Dipodidae, and the Spalacidae show simpler dentition than the Muridae. These three possess a gall bladder. The Muridae claims more genera than any other mammalian family and probably more individuals. In this family, the gall bladder is constantly present in some genera and absent in others. Its presence or absence may even be found in different species of the same genus.

Some tendencies among the subfamilies are distinguishable. The Cricetinae, Lophiomyinae, and Hydromyinae usually do not possess the organ, while the Gerbillinae apparently tend to retain it. Among the Murinae proper, available records (nine genera) indicate variability in this subfamily. The present distribution and the large number of species and subspecies show that these rodents are not only very successful, but that they are at a morphologically plastic stage in their development. The habits of the group and the variable presence of the gall cyst hint at its eventual disappearance.

Hystricomorph rodents generally possess a gall bladder, but in a few instances the organ is absent. The New World porcupines, the Erethizontidae, all lack the organ, but it was present in six out of eight dissections of the Old World forms. The Erethizontidae have been distinct since the Oligocene.

DISCUSSION

From the above evidence, several facts are forthcoming. In the first place, it will be seen that the gall bladder is present in all carnivorous forms (except whales), and that it may be lacking among omnivorous or herbivorous forms. A carnivorous animal of necessity consumes only occasional meals, and these have a high fat content. From a physiological point of view, storage of concentrated bile should be a great aid in the digestion of such meals, and it is significant that the organ is constantly present in animals having these habits.

The absence of the organ in species of other dietary habits, is indicated by the evidence of Schmidt and Ivy. They found species in which the organ had no apparent or demonstrable function. It may be said that the organ was "physiologically absent." Species possessing this type of gall bladder are usually members of an order in which there are other species in which the organ is anatomically absent. Further, the gall bladder is not absent from those species which have descended most directly, or with the least specialization in regard to body form, from the ancestor of mammals.

Another factor which may influence the existence of the gall bladder in a given species is the proximity of this species to the ancestral form. It will be noted that those species, families, or orders which most closely resemble the ancestor of a given group tend constantly to retain the gall cyst, while those which vary most, tend to lose the organ. The fact that other parts of the digestive tract adapt themselves quickly to dietary habits, suggests that the gall cyst may be the least plastic of the digestive organs. It is true, however, that it has completely disappeared in some mammalian families, whereas the stomach, caecum, and colon have not, although they frequently have undergone marked variations in form.

The stable nature of the gall bladder suggests that it may have taxonomic value. In only nine families was the organ found to be present in some members and absent in others. In at least six of these the variation occurred between species or individuals. In the remaining three, it was possible to arrange subfamilies, and here, for the most part, definite tendencies following the lines of arrangement were demonstrable. Individual variations in the organ are probably comparable to the anomalies occasionally seen in the human cadaver. The frequency with which these anomalies occur may be a measure of the declining "need" for the organ. Thus in the dissections of *Procavia*, three observers found a gall bladder; five did not. On the other hand, with the giraffe the records show only two gall bladders out of about twenty dissections. From these records, it might be concluded that these animals will soon lose the organ completely.

It is interesting that closely related species, particularly among the Muridae, may differ in the possession of the organ. Besides this, the occurrence of anomalous absences in individuals of the same species suggests that it might be possible to study the mechanism of the inheritance of the organ.

CONCLUSIONS

(1) The gall bladder is a typical vertebrate structure, found first in larval agnathostomes and generally throughout the rest of the group.

(2) All reptiles and amphibians have a gall bladder.

(3) In birds the presence of the gall cyst is extremely variable, but carnivorous birds generally retain it.

(4) The gall bladder is a primitive mammalian structure. It is not easily lost. It is not as readily lost as the form of the stomach, caecum, and colon is changed; i.e. a complex stomach may appear in a line of descent without the gall bladder's being lost. It is usually retained in forms which most closely resemble the ancestral type; forms which vary most widely may lose it.

(5) Carnivorous mammals (except whales) possess a gall bladder, while mammals with other dietary habits may lose the organ. This apparently is related to the intermittent feeding habits of carnivorous types. Herbivorous forms with continuous feeding habits are most likely to lack the organ.

(6) From the evidence of the dietary habits of cholecystous and acholecystous forms, one may conclude that if the gall bladder is removed from a given individual of any species, digestive efficiency will be diminished only if (*a*) the organ has a large physiologic capacity, and (*b*) intermittent meals of a high fat content are given.

(7) There is no anatomical evidence to indicate that the *Sphincter ductus choledochus* developed before a gall cyst. Yet the presence of such a sphincter renders a gall bladder essential as a pressure regulatory apparatus, unless the common bile duct manifests definite peristaltic activity, as, for example, in the guinea pig.

TABLES

Unless otherwise indicated all numbers are catalogue numbers of specimens in Field Museum. The presence of the gall bladder is indicated by + its absence by −. The name in parentheses is the one used by the original author. References to Gorham, 1936, are to Field Museum specimens dissected but not preserved.

TABLE 1.—AMPHIBIA

Apoda	
Caecilidae	
+*Typhlonectes compressicauda*	
+*Typhlonectes natans*	Fuhrmann 1914.
+*Typhlonectes dorsalis*	
Salientia	
Pipidae	
+*Pipa pipa* (*P. americana*)	Beddard 1895a.
Pelobatidae	
+*Megophrys montana* (*Xenophrys monticola*)	
+*Megophrys hasseltii* (*Leptobatrachium*)	Beddard 1907a.
+*Megophrys feae* (*Megalophrys*)	
Rhinophrynidae	
+*Rhinophrynus dorsalis*	Günther 1858.
Leptodactylidae	
+*Pseudis paradoxa* (*Rana*)	Hunter 1861.
Microhylidae	
+*Breviceps verrucosus*	Beddard 1908.
Ranidae	
+*Rana pipiens*	Gorham 1936.
Caudata	
Necturidae	
+*Megalobatrachus japonicus*	Beddard 1903.
+*Cryptobranchus alleghaniensis* (*Menopoma*)	
Sirenidae	
+*Siren lacertina*	
Amphiumidae	Hunter 1861.
+*Amphiuma means* (*A. didactylum*)	
Salamandridae	
+*Salamandra salamandra* (*S. maculata*)	

TABLE 2.—REPTILIA

Sauria	
Gekkonidae	
+*Gekko gecko*	8914.
Eublepharidae	
+*Coleonyx mitratus*	5051.
Pygopodidae	
+*Lialis jicari*	13869.
Agamidae	
+*Agama agama*	19815.
+*Calotes mystaceus*	14492.
+*Chlamydosaurus kingi*	Beddard 1905.
Iguanidae	
+*Crotaphytus collaris*	637.
+*Phrynosoma blainvilli*	8056.
Cordylidae	
+*Cordylus giganteus*	19258.
+*Platysaurus guttatus*	17322.
+*Chamaesaura aenea*	17465.

TABLE 2.—REPTILIA (*Continued*)

Sauria (*continued*)	
Anguidae	
+*Gerrhonotus infernalis*	11200.
+*Anguis fragilis*	22895.
+*Ophisaurus apus*	15680.
Anniellidae	
+*Anniella pulchra*	Coe & Kunkel 1906.
Helodermatidae	
+*Heloderma suspectum*	Shufeldt 1890.
Varanidae	
+*Varanus niloticus*	Beddard 1907.
Xantusiidae	
+*Lepidophyma flavomaculata*	21788.
Teiidae	
+*Ameiva ameiva*	16585.
Amphisbaenidae	
+*Amphisbaena alba*	17802.
Lacertidae	
+*Lacerta viridis*	15749.
Gerrhosauridae	
+*Gerrhosaurus nigrolineatus*	18506.
Scincidae	
+*Eumeces schneideri*	19636.
Feyliniidae	
+*Typhlosaurus vermis*	16031.
Dibamidae	
+*Dibamus novae-guineae*	14251.
Chamaeleontidae	
+*Chamaeleo pumilis* (*Chamaeleon*)	Beddard 1907b.
+*Chamaeleo parvilobus* (*Chamaeleon*)	Beddard 1907b.
+*Chamaeleo dilepis* (*Chamaeleon*)	Beddard 1907b.
*—*Chamaeleo verrucosus* (*Chamaeleon*)	Beddard 1907b.
+*Chamaeleo verrucosus* (*Chamaeleon*)	18277.
+*Rhampholeon spectrum*	19855.
Serpentia	
Typhlopidae	
+*Typhlops punctatus*	21081.
Leptotyphlopidae	
+*Leptotyphlops albifrons*	87.
Boidae	
+*Charina bottae*	Cope 1898.
+*Constrictor constrictor*	11404.
+*Sanzinia madagascarensis* (*Corallus*)	Beddard 1906a.
Pythonidae	
+*Python bivittatus*	8925.
+*Python sebae*	Beddard 1904.
Aniliidae	
+*Anilius scytale*	16943.
+*Anilius scytale* (*Ilysia*)	Beddard 1906.
+*Anilius scytale* (*Boa*)	Owen 1833a.

* Beddard could not find the organ.

TABLE 2.—REPTILIA (*Continued*)

Serpentia (*continued*)	
Uropeltidae	
+*Rhinophis blythii*	Peters 1861.
+*Rhinophis oxyrhynchus*	
Xenopeltidae	
+*Xenopeltis unicolor*	11523. Thompson 1913.
Achrochordidae	
+*Chersydrus granulatus*	Cope 1898.
Colubridae	
+*Elaphe quadrivittata*	
+*Heterodon contortrix*	
+*Coluber constrictor*	Gorham 1936.
Dasypeltidae	
+*Dasypeltis macrops*	19455.
Homalopsidae	
+*Enhydris enhydris*	11556.
Boigidae	
+*Boiga dendrophila*	11128.
Disteiridae	
+*Pelamis platurus*	16926.
Elapidae	
+*Naja nigricollis*	12873.
+*Naja hannah*	Beddard 1903a.
+*Micrurus fulvius*	8488.
Amblycephalidae	
+*Amblycephalus moellendorffii*	6662.
Viperidae	
+*Vipera berus*	21766.
Crotalidae	
+*Crotalus viridis* (*C. confluentus*)	Cope 1898.
+*Crotalus horridus*	Owen 1833a.
Testudinata	
Dermochelidae	
+*Dermochelys coriacea*	Burne 1905.
Chelhydridae	
+*Chelydra serpentina*	Martin 1830b.
Testudinidae	
+*Emys orbicularis* (*E. lutraria*)	Hunter 1861.
+*Testudo elephantina* (*T. indica*)	Martin 1830.
+*Testudo elephantina* (*T. elephantopus*)	Hunter 1861.
+*Testudo graeca*	Martin 1830a.
+*Geoemyda trijuga* (*Emys*)	Anderson 1879.
+*Kachuga ahongoka*	
+*Clemmys leprosa*	Kollman 1912.
+*Testudo mauritanica*	
Cheloniidae	
+*Chelonia mydas* (*Chelone*)	Hunter 1861.
Crocodilia	
Crocodilidae	
+*Crocodylus cataphractus* (*C. leptorhyncus*)	Martin 1835b.
+*Crocodylus niloticus* ("Crocodile du Nile")	Geoffroy 1803.
+*Crocodylus acutus*	Owen 1831d.
Rhynchocephalia	
Sphenodontidae	
+*Sphenodon punctatus* (*Hatteria*)	Günther 1867.

TABLE 3.—AVES

Struthioniformes	
Struthionidae	
−*Struthio camelus*	Garrod & Darwin 1872. Hunter 1861. Rothschild 1900.
Rheiformes	
−Rheidae	Rothschild 1900.
Casuariiformes	
Casuariidae	
+*Casuarius*	
Dromiceiidae	Rothschild 1900.
+*Dromiceius*	
+*Dromiceius novae-hollandiae*	Boulart 1900.
Apterygiformes	
Apterygidae	
+*Apteryx australis*	Owen 1838.
Sphenisciformes	
Spheniscidae	
+*Aptenodytes patagonica*	Reid 1835.
Procellariiformes	
+Procellariidae	Forbes 1882a.
Pelecaniformes	
Phaëthontidae	
+*Phaëthon lepturus* (*P. flavirostris*)	Beddard 1897a.
Pelecanidae	
+*Pelecanus rufescens*	Martin 1835a.
+*Pelecanus occidentalis* (*P. fuscus*)	
+*Pelecanus onocrotalus*	
Phalacrocoracidae	Hunter 1861.
+*Phalacrocorax carbo*	
Anhingidae	
+*Anhinga anhinga* (*Plotus*)	Garrod 1876b.
Ciconiiformes	
Ardeidae	
+*Ardea cinerea*	
+*Ardea purpurea* (*Nycticorax*)	Hunter 1861.
+*Botaurus stellaris*	
+*Nycticorax nycticorax* (*N. europaeus*)	
Cochleariidae	
+*Cochlearius cochlearius* (*Cancroma*)	Murie 1867a.
Balaenicipitidae	
+*Balaeniceps rex*	Beddard 1888. Fox 1929. Mitchell 1913.
Scopidae	
+*Scopus umbretta*	Beddard 1884.
Ciconiidae	
+*Leptoptilos crumeniferus*	Mentzer 1929.
Phoenicopteridae	
+*Phoenicopterus ruber*	Hunter 1861.
Anseriformes	
Anhimidae	
+*Anhima cornuta* (*Palamedea corniculata*)	Beddard 1894.
+*Chauna chavaria*	Beddard 1886. Mitchell 1895.

TABLE 3.—AVES (*Continued*)

Anseriformes (*continued*)	
Anatidae	
+*Cygnus olor*	Hunter 1861.
+*Branta canadensis* (*Anser*)	
+*Branta bernicla*	Fox 1923.
+*Branta leucopsis*	Hunter 1861.
+*Cairina moschata* (*Anser*)	
+*Eulabeia indica*	Fox 1927.
+*Mergellus albellus* (*Mergus*)	Kuhl 1820.
Falconiformes	
Accipitridae	
+*Gyps fulvus* (*Vultur*)	Hunter 1861.
+*Aquila chrysaëtos*	
+*Haliaeetus albicilla*	
+*Accipiter nisus* (*Astur*)	
+*Accipiter gentilis* (*Astur palumbarius*)	
+*Aviceda leuphotes*	97002.
Falconidae	
−*Falco peregrinus*	Kuhl 1820.
Galliformes	
Cracidae	
+*Penelope purpurascens* (*P. cristata*)	Hunter 1861.
Phasianidae	
+*Arborophila brunneopectus*	97003.
Numididae	
+*Numida meleagris*	Hunter 1861.
Opisthocomidae	
−*Opisthocomus hoazin* (*O. cristatus*)	Young 1888.
Gruiformes	
Turnicidae	
−*Turnix tanki*	97007.
Gruidae	
+*Anthropoïdes virgo* (*Grus*)	Hunter 1861.
Aramidae	
+*Aramus scolopaceus*	Garrod 1876a.
Rallidae	
+*Porphyrio albus*	Hunter 1861.
+*Notornis mantelli*	Benham 1899.
Heliornithidae	
−*Podica senegalensis*	Beddard 1890a.
Rhynochetidae	
+*Rhynochetos jubatus*	Murie 1867a.
Cariamidae	
+*Cariama cristatus* (*Dicholophus*)	Martin 1836.
Otidae	
+*Otis tarda*	Fox 1929.
Charadriiformes	
Jacanidae	
+*Jacana spinosa* (*Parra*)	Forbes 1881a.
Charadriidae	
+*Vanellus vanellus* (*V. vulgaris*)	Kuhl 1820.
Scolopacidae	
−*Erolia alpina* (*Tringa*)	
+*Calidris canutus* (*Arenaria calidris*)	
+*Numenius arquata*	Hunter 1861.
+*Limnodromus griseus*	Gorham 1936.
Phalaropodidae	
+*Lobipes lobatus*	

TABLE 3.—AVES (*Continued*)

Charadriiformes (*continued*)	
Laridae	
+*Larus marinus*	Hunter 1861.
+*Larus argentatus*	Hill 1926.
+*Larus ridibundus*	Kuhl 1820.
Alcidae	
+*Uria aalge* (*troile*)	Hunter 1861.
+*Uria aalge*	Kuhl 1820.
+*Synthliborhamphus antiquus*	Shufeldt 1887.
+*Brachyramphus marmoratus*	
Columbiformes	
Pteroclididae	
+*Pterocles orientalis* (*P. arenarius*)	Gadow 1882. Garrod 1874.
+*Syrrhaptes*	Garrod 1874.
Columbidae	
+*Ptilinopus insolitus* (*Aedirhinus*)	Haswell 1882.
+*Coryphoenas crassirostris* (*Turacoena*)	
–*Columba*	Garrod 1874.
–*Turtur*	
–*Macropygia*	
–*Ectopistes*	
–*Chamaepelia*	
–*Metriopelia*	
–*Zenaida*	
–*Caloenas*	
–*Didunculus*	
–*Chalcopelia*	
–*Tympanistria*	
–*Ocyphaps*	
–*Leucosarcia*	
–*Phaps*	
–*Phlogoenas*	
–*Starnoenas*	
–*Geopelia*	
–*Goüra*	
+*Carpophaga*	
+*Lopholaemus*	
+*Ptilonopus*	
–*Treron*	
–*Columba vitiensis halmaheira* (*Ianthoenas leucolaema*)	Garrod 1875a.
–*Alectroenas pulcherrima* (*Erythroenas*)	
Psittaciformes	
–Psittacidae	Cuvier 1835. Beddard 1898. Fox 1923.
+*Kakatoe goffini* (*Cacatua*)	Garrod 1877b.
+*Kakatoe moluccensis* (*Cacatua*)	
+*Kakatoe haematuropygia* (*Cacatua philippinarum*)	
+*Nymphicus hollandicus* (*Calopsitta novae-hollandiae*)	
Cuculiformes	
Musophagidae	
+*Gallirex porphyreolophus* (*Corythaix*)	Owen 1834.
+*Turacus persa* (*Corythaix buffoni*)	Martin 1836a.
Cuculidae	
+*Carpococcyx radiatus*	Beddard 1901a.
+*Scythrops novae-hollandiae*	Beddard 1898a.
+*Cuculus canorus*	Hunter 1861.
+*Centropus sinensis*	97014.

TABLE 3.—AVES (*Continued*)

Strigiformes	
Strigidae	
+*Scotopelia peli*	Murie 1871.
+*Phodilus badius*	Beddard 1890.
+*Asio otus* (*Otus aurita*)	Hunter 1861.
Caprimulgiformes	
Steatornithidae	
+*Steatornis*	Beddard 1886a.
Podargidae	
+*Batrachostomus*	Blyth 1866.
+*Batrachostomus*	
+*Podargus*	
Aegothelidae	
+*Aegotheles*	Beddard 1886a.
Caprimulgidae	
+*Caprimulgus*	
−*Chordeiles* sp.	
+*Chordeiles minor minor*	Gorham 1936.
+*Nyctidromus*	Beddard 1886a.
Micropodiformes	
Trochilidae	
−*Archilochus colubris*	Crisp 1862a.
−*Campylopterus ensipennis*	97208.
Trogoniformes	
Trogonidae	
+*Harpactes erythrocephalus*	97017.
Coraciiformes	
Alcedinidae	
−*Halcyon smyrnensis*	97019.
Meropidae	
+*Melittophagus erythrocephalus*	97187.
Leptosomatidae	
+*Leptosomus discolor*	Forbes 1880a. Grandidier and Milne-Edwards 1875.
Bucerotidae	
+*Bucorvus abyssinicus*	Garrod 1876.
+*Dichoceros bicornis* (*Buceros cavatus*)	Owen 1833.
Piciformes	
Capitonidae	
+*Trachylaemus goffinii*	97232.
+*Megalaema virens*	
+*Cyanops franklinii* (*Megalaema*)	
+*Xantholaema rosea*	
Ramphastidae	
+*Aulacorhynchus prasinus* (*Aulacorhamphus*)	Forbes 1882.
+*Ramphastos discolorus*	
+*Ramphastos vitellinus*	
+*Ramphastos piscivorous* (*R. carinatus*)	
+*Pteroglossus aracari* (*P. wiedi*)	
+*Selenidera maculirostris*	
Picidae	
−*Picumnus squamulatus*	97216.

TABLE 3.—AVES (*Continued*)

Passeriformes	
Formicariidae	
+*Myrmotherula schisticolor*	97214.
Tyraniidae	
+*Mecocerculus leucophrys*	97220.
Pittidae	
−*Pitta oatesi*	97035. 97034.
Philepittidae	
−*Philepitta*	Forbes 1880b.
Hirundinidae	
+*Psalidoprocne fuliginosa*	97260.
Campephagidae	
+*Pericrocotus flammeus*	97029.
Dicruridae	
−*Chaptea aenea*	97032.
Oriolidae	
+*Oriolus chinensis*	97033.
Corvidae	
+*Chripsirhina temia*	97042.
+*Corvus brachyrhynchos*	Gorham 1936.
+*Pyrrhocorax pyrrhocorax*	Hunter 1861.
Paridae	
−*Aegithaliscus annamensis*	97142.
Timeliidae	
+*Mesia argentauris*	97109.
−*Alcippe nipalensis*	97092. 97090.
−*Mixornis rubricapilla*	97077. 97081.
+*Garrulax leucolophus*	97048.
+*Garrulax vassali*	97045.
+*Stachyris nigriceps*	97055. 97053.
Pycnonotidae	
+*Criniger gularis*	97129.
+*Otocompsa flaviventris*	97118. 97144.
Turdidae	
+*Luscinia calliope*	97149. 97152. 97153.
Sylviidae	
+*Orthotomus sutorius*	97186.
Muscicapidae	
−*Siphia parva*	97166.
+*Muscicapula rubeculoides*	97172.
+*Culicicapa ceylonensis*	97163.
Motacillidae	
+*Anthus hodgsoni*	97186.
Bombycillidae	
−*Bombycilla garrula*	Kuhl 1820.
Laniidae	
+*Laniarius atroflavus*	97257.
+*Lanius excubitor*	Hunter 1861.
Nectariniidae	
−*Cinnyris reichenowi*	97281. 97282.
−*Cinnyris jugularis*	97189.
−*Aethopyga saturata*	97194.

TABLE 3.—AVES (*Continued*)

Passeriformes (*continued*)	
Dicaeidae	
+*Dicaeum concolor*	97201.
Zosteropidae	
+*Zosterops palpebrosa*	97203.
+*Zosterops virens*	97284.
Ploceidae	
+*Estrilda melpoda*	97254.
+*Munia striata*	97205.
Icteridae	
+*Zarhynchus wagleri*	97229.
Thraupidae	
+*Calospiza chrysophrys guttata*	97217.
+*Thraupis cyanocephala subcinerea*	97218.
Fringillidae	
+*Atlapetes semirufus*	97211.

TABLES 4–16.—MAMMALIA

TABLE 4

Monotremata	
Ornithorhynchidae	
+*Ornithorhynchus anatinus*	Owen 1838. Crisp 1862. Flower 1872.
+*Ornithorhynchus anatinus* ("Platypus")	Mackenzie 1918.
Tachyglossidae	
+*Tachyglossus aculeatus* (*Echidna hystrix*)	Owen 1866. Rex 1888. Flower 1872. Chapman 1887.
+*Tachyglossus aculeatus* (*Echidna* sp.)	Mackenzie 1918.

TABLE 5

Marsupialia	
Didelphiidae	
+*Didelphis marsupialis*	Mackenzie 1918. Hunter 1861. Flower 1872.
+*Didelphis paraguayensis* (*D. azarae*)	Martin 1834a. Jones 1834a.
+*Didelphis virginianus*	Gorham 1936.
+*Monodelphis brevicaudatus* (*Didelphis hunteri*)	Hunter 1861.
Dasyuridae	
+*Dasyurus quoll* (*D. viverrinus*)	Mackenzie 1918.
+*Antechinomys laniger*	Alston 1880. Beddard 1908b.
+*Thylacinus* sp.	Crisp 1862.
+*Phascogale tapoatafa* (*P. pencillata*)	Hunter 1861.
+*Sarcophilus harrisi*	Mackenzie 1918.
Notoryctidae	
+*Notoryctes typhlops*	Carlsson 1904.
Paramelidae	
+*Chaeropus castanotis*	Parsons 1903.
Phalangeridae	
+*Phalanger maculatus* (*Cuscus*)	Forbes 1881.
+*Trichosurus vulpecula* (*Phalangista vulpina*)	Forbes 1881. Mackenzie 1918.
+*Pseudochirus* sp.	Mackenzie 1918.
+*Schoinobates volans* (*Petaurus taguanoides*)	Hunter 1861

TABLE 5—*Continued*

Marsupialia (*continued*)	
Phascolarctidae	
+*Phascolarctos cinereus*	Forbes 1881. Sonntag 1921. Mackenzie 1918.
Wombatidae	
+*Wombatus ursinus* (*Phascolomys wombat*)	Forbes 1881.
+*Wombatus ursinus* ("Wombat")	Cleland 1869.
+*Wombatus ursinus* (*Phascolomys* sp.)	Mackenzie 1918.
Macropodidae	
+*Macropus cangaru* (*M. major*)	Hunter 1861. Crisp 1862.
+*Macropus cangaru* (*M. giganteus*)	Flower 1872.
+*Macropus parryi*	Mackenzie 1918.
+*Macropus walabatus*	Mackenzie 1918.
+*Megaleia rufa* (*Macropus ruber*)	Crisp 1862.
+*Dendrolagus inustus*	Crisp 1862. Owen 1852.
+*Dorcopsis luctuosa* (*Halmaturus luctuosus*)	Garrod 1875.
+*Dorcopsis luctuosa* (*Halmaturus xanthopis*)	Crisp 1862.
+*Potorous tridactylus* (*Hypsiprymnus murinus*)	Hunter 1861.
Caenolestidae	
+*Caenolestes obscurus*	Osgood 1921.
Myrmecobiidae	
+*Myrmecobius fasciata*	Mackenzie 1936.

TABLE 6

Insectivora	
Tenrecidae	
+*Oryzorictes hova*	Dobson 1882.
+*Centetes caudatus*	Dobson 1882.
Potomogalidae	
*+*Potomogale velox*	Seabra 1901.
Solenodontidae	
+*Solenodon paradoxus*	Allen 1910.
+*Atopogale cubanus* (*Solenodon*)	Dobson 1882.
Chrysochloridae	
+*Chrysochloris asiatica* (*C. aurea*)	Dobson 1882.
+*Chrysospalax dobsoni* (*Chrysochloris villosa*)	Dobson 1882.
+*Amblysomus hottentotus* (*A. rutilans*)	Dobson 1882.
+*Amblysomus obtusirostris* (*Chrysochloris*)	Peters 1852.
Erinaceidae	
+*Erinaceus europaeus*	Dobson 1881. Hunter 1861. Flower 1872. Hill 1926.
+*Echinosorex albus* (*Gymnura rafflesi*)	Allen 1910.
+*Paraechinus deserti* (*Erinaceus algirus*)	Dobson 1882.
+*Paraechinus micropus* (*Erinaceus pictus*)	Dobson 1882.
+*Paraechinus amir* (*Erinaceus macracanthus*)	Dobson 1882.
+*Paraechinus blanfordi* (*Erinaceus jerdoni*)	Dobson 1882.
+*Paraechinus niger*	Dobson 1882.
+*Hemiechinus grayi* (*Erinaceus grayi*)	Dobson 1882.
+*Atelerix albiventris* (*Erinaceus*)	Dobson 1882.
+*Aethechinus angolae* (*Erinaceus diadematus*)	Dobson 1882.
+*Ericulus telfairi* (*Echinops*)	Martin 1838.
Soricidae	
+*Sorex vulgaris*	Arnback 1907.
+*Sorex araneus*	Hill 1926.
+*Crocidura hirta*	Peters 1852.
+*Blarina brevicauda*	16545.

*Called "Vesicula vermiculair."

TABLE 6—*Continued*

Insectivora (*continued*)	
Talpidae	
+*Talpa europea*	Hunter 1861. Flower 1872.
+*Desmana moschata* (*Myogale*)	Dobson 1882.
+*Scapanus latimanus* (*Scapanus townsendi*)	Dobson 1882.
Tupaiidae	
+*Tupaia belangeri*	Garrod 1879.
+*Ptilocercus lowii*	Clark 1926.
+*Dendrogale frenata*	46628.
Macroscelididae	
+*Rhynchocyon cirnei*	Peters 1852.
+*Nasilio brachyrhynchus* (*Macroscelides fuscus*)	Peters 1852.
+*Petrodromus tetradactylus*	Peters 1852.
+*Macroscelides rozeti*	Duvernoy and Lereboullet 1840.

TABLE 7

Dermoptera	
Galeopithecidae	
+*Galeopithecus* sp.	Flower 1872. Cuvier 1835.
+*Galeopterus temmincki* (*Galeopithecus volans*)	Chapman 1902.

TABLE 8

Chiroptera	
Pteropidae	
+*Pteropus rufus rufus* (*P. edwardsi*)	Flower 1872.
+*Pteropus giganteus giganteus* (*P. medius*)	Robin 1881.
+*Pteropus subniger* (*P. rubicollis*)	Robin 1881.
+*Pteropus edwardsi* (*P. edwardsii*)	Peters 1852.
Cynopteridae	
*+*Cynopterus brachyotis* (*C. scherzeri*)	Robin 1881.
*+*Penthetor jagori* (*Cynopterus*)	Robin 1881.
*+*Epomops franqueti* (*Epomorphus comptus*)	Robin 1881.
*+*Hypsignathus monstrosus*	Robin 1881.
*+*Nyctymene cephalotes* (*Eonycteris*)	Robin 1881.
*+*Roussettus amplexicaudatus* (*Cynonycteris*)	Robin 1881.
+*Roussettus collaris* (*Cynonycteris*)	Peters 1852.
+*Epomophorus crypturus*	Peters 1852.
Rhinopomidae	
+*Rhinopoma microphyllum*	Robin 1881.
Emballonuridae	
*+*Emballonura nigrescens*	Robin 1881.
*+*Rhynchiscus naso* (*Rhynchonycteris*)	Robin 1881.
*+*Balantiopteryx plicata* (*Saccopteryx*)	Robin 1881.
*+*Taphozus melanopogon*	Robin 1881.
+*Coleura afra* (*Emballonura*)	Peters 1852.
Noctilionidae	
+*Noctilio leporinus*	Robin 1881.
+*Noctilio albiventer*	Cuvier 1835.
Nycteridae	
*+*Nycteris thebaica*	Robin 1881.
*+*Nycteris revolii*	Robin 1881.
+*Nycteris hispida* (*N. villosa*)	Peters 1852.

* The absence of the gall bladder was not noted.

TABLE 8—*Continued*

Chiroptera (*continued*)	
Megadermidae	
*+*Megaderma spasma*	
Rhinolophidae	
*+*Rhinolophus ferrum-equinum*	Robin 1881.
+*Rhinolophus hipposideros*	
*+*Rhinolophus euryale*	
+*Rhinolophus lobatus*	Peters 1852.
Hipposideridae	
+*Hipposideros diadema* (*Phyllorhina*)	Robin 1881.
*+*Hipposideros commersoni* (*Phyllorhina*)	
+*Hipposideros commersoni* (*Phyllorrhina vittata*)	Peters 1852.
*+*Hipposideros armiger* (*Phyllorhina*)	
Phyllostomidae	
*+*Phyllostomus hastatus*	
*+*Macrotus waterhousii*	Robin 1881.
*+*Glossophaga soricina*	
*+*Carollia perspicillata* (*C. brevicauda*)	
*+*Artibeus jamaicensis* (*A. perspicillatus*)	
+*Vampyrus spectrum*	Cuvier 1835.
Desmodontidae	
+*Desmodus rotundus* (*D. rufus*)	Flower 1872.
Vestertiliolidae	
+*Vespertilio murinus*	Robin 1881. Cuvier 1835.
+*Myotis myotis* (*Vespertilio*)	Kuhl 1820.
+*Myotis mystocinus* (*Vespertilio*)	
*+*Scotophilus temminckii*	Robin 1881.
*+*Pipistrellus kuhlii* (*Vesperugo*)	
+*Pipistrellus pipistrellus* (*Vespertilio*)	Cuvier 1835.
+*Nyctalus noctula* (*Vesperugo*)	Flower 1872. Hill 1926. Cuvier 1835.
*+*Lasiurus borealis* (*Atalapha noveboracensis*)	
*+*Barbastella barbastella* (*Synotus*)	Robin 1881.
*+*Plecotus auritus*	
+*Plecotus auritus*	Cuvier 1835.
+*Eptesicus serotinus* ("Vespertillion")	
+*Eptesicus serotinus* (*Vespertilio*)	Kuhl 1820.
+*Scotophilus nigrita* (*Nycticejus planirostris*)	Peters 1852.
*+*Miniopterus schreibersii*	
*+*Kerivoula hardwickii*	
Molossidae	
*+*Molossus obscurus*	
*+*Chaerephon plicatus* (*Nyctinomus*)	Robin 1881.
+*Cheiromeles torquatus*	
*+*Tadarida brasiliensis* (*Nyctinomus*)	
*+*Mormopterus acetabulosus* (*Nyctinomus*)	
+*Nyctinomous limbatus* (*Dysopes*)	Peters 1852.
+*Nyctinomus taeniotus* (*Dinops cestoni*)	Cuvier 1835.

TABLE 9

Primates	
Lemuridae	
+*Lemur mayottensis*	Beddard 1884a.
+*Lemur mongoz*	Hunter 1861. Ruge 1902.
+*Lemur macaco*	Martin 1831.

* The absence of the gall bladder was not noted.

TABLE 9—*Continued*

Primates (*continued*)	
Lemuridae (*continued*)	
+*Lemur catta*	Hunter 1861.
+*Lemur fulvus*	Flower 1872.
+*Lemur fulvus* (*L. albifrons*)	Hunter 1861.
+*Lemur variegatus* (*L. varius*)	Flower 1872. Grandidier and Milne-Edwards 1875.
+*Microcebus murinus*	Flower 1872.
+*Microcebus murinus* (*M. smithi*)	Ruge 1902.
+*Propithecus diadema*	Grandidier and Milne-Edwards 1875.
+*Hapalemur griseus*	Beddard 1884a.
+*Hapalemur simus*	Beddard 1901.
Indrisidae	
+*Indris indris* (*Avahi laniger*)	Ruge 1902. Grandidier and Milne-Edwards 1875.
Daubentoniidae	
+*Daubentonia madagascarensis* (*Chiromys*)	Ruge 1902. Mivart and Murie 1865.
+*Daubentonia madagascarensis* ("aye-aye")	Owen 1866.
Lorisidae	
+*Loris tardigradus* (*Nycticebus*)	Ruge 1902.
+*Loris tardigradus*	Hunter 1861. Flower 1872.
+*Loris tardigradus* (*Nycticebus*)	Mivart and Murie 1865.
+*Loris tardigradus* (*Stenops gracilis*)	Kuhl 1820.
+*Nycticebus javanicus* +*Arctocebus calabarensis*	Flower 1872.
+*Perodicticus potto*	Ruge 1902. Flower 1872.
+*Galago madagascarensis*	Kuhl 1820.
+*Galago crassicaudatus*	Flower 1852.
+*Galago mohali*	Smith 1849.
+*Myoxicebus griseus* (*Hapalemur*)	Beddard 1901. Grandidier and Milne-Edwards 1875.
Tarsiidae	
+*Tarsius fuscus* (*T. spectrum*)	Ruge 1902. Sonntag 1924. Woollard 1925.
Callitrichidae	
+*Oedipomidas oedipus* (*Midas*)	Flower 1872.
+*Callithrix jacchus* (*Hapale*)	Hunter 1861. Beattie 1927. Flower 1872.
Cebidae	
+*Cebus capucinus*	Sonntag 1924. Crisp 1862. Ruge 1902a. Flower 1872.
+*Cebus apella*	Hunter 1861.
+*Ateles geoffroyi*	Flower 1872.
+*Ateles cucullatus*	Murie 1865.
+*Ateles ater*	Ruge 1902a.
+*Ateles belzebuth*	Kuhl 1820.
+*Pithecia pithecia*	Sonntag 1924.
+*Pithecia monacha*	Flower 1862.
+*Cacajao rubicundus* (*Brachyurus*)	Forbes 1880.
+*Alouatta senicula*	Flower 1872.
+*Saimiri sciurea* (*Callithrix sciureus*)	Martin 1833.

TABLE 9—*Continued*

Primates (*continued*)	
Cercopithecidae	
+*Cercopithecus albogularis*	Mentzer 1929. Owen 1832a.
+*Cercopithecus erythrogaster*	Murie 1866.
+*Cercopithecus cynosurus*	Ruge 1906.
+*Cercopithecus talapoin*	Ruge 1906.
+*Cercopithecus cephna* (*C. cephus*)	Ruge 1906.
+*Cercopithecus nictitans*	Ruge 1906.
+*Cercopithecus callithricus* (*C. sabaena*)	Hunter 1861.
+*Cercopithecus petaurista*	Ruge 1906.
+*Cercopithecus sinicus*	Kuhl 1820.
+*Cercopithecus aethiops*	Kuhl 1820.
+*Cercocebus fuliginosus*	Bradley 1903.
+*Erythrocebus patas* (*Cercopithecus*)	Ruge 1906.
+*Colobus vellerosus*	Flower 1872.
+*Theropithecus rueppelli* (*Gelada*)	Garrod 1879a.
+*Papio lestes*	Mentzer 1929.
+*Papio sphinx*	Ruge 1906.
+*Papio maimon*	Ruge 1906. Hunter 1861.
+*Papio anubis*	Ruge 1906. Hunter 1861. Flower 1872.
+*Papio porcarius*	Hunter 1861.
+*Papio leucophaeus* (*Mandrillus*)	Sonntag 1922.
+*Papio hamadryas*	Schrieber 1932.
+*Macaca maura*	Murie 1872.
+*Macaca brunnea*	Anderson 1872.
+*Macaca albibarbata* (*M. silenus*)	Hunter 1861.
+*Macaca mulatta* (*M. rhesus*)	Hunter 1861.
+*Macaca mulatta* (*M. rhesus*)	Linback 1933.
+*Macaca cynomolga*	Ruge 1906.
+*Macaca sinica*	Ruge 1906.
+*Macaca nemestrina*	Ruge 1906.
Pongidae	
+*Hylobates lar*	Ruge 1906a. Hunter 1861. Flower 1872.
+*Hylobates lar* (*H. leuciscus*)	Chapman 1900.
+*Pongo pygmaeus* ("orang")	Owen 1830. Sonntag 1924a. Ruge 1906a.
+*Pan satyrus* ("chimpanzee")	Ruge 1906a. Fox 1929.
+*Pan satyrus* (*Anthropopithecus troglodytes*)	Sonntag 1923.
+*Gorilla gorilla*	Flower 1872. Fox 1930. Ruge 1906a.
Hominidae	
+*Homo sapiens*	*A. U. C.*

TABLE 10

Carnivora	
Canidae	
+*Canis familiaris*	Gorham 1936.
+*Canis aureus*	Mentzer 1929.
+*Canis lupus*	Macalister 1867.
+*Speothos venaticus* (*Icticyon*)	Flower 1880.
+*Lycaon pictus*	Crisp 1855. Garrod 1878a.

TABLE 10—*Continued*

Carnivora (*continued*)	
Canidae (*continued*)	
+*Otocyon virgatus* (*Canis otocyon virgatus*)	Mentzer 1929.
+*Urocyon cinereoargenteus* (*Canis*)	Hunter 1861.
+*Cuon dukhunensis*	Murie 1872c.
+*Fennecus zerda* (*Canis*)	Hunter 1861.
+*Nyctereutes procyonoides*	Garrod 1878a.
Procyonidae	
+*Procyon lotor*	Crisp 1862. Macalister 1867.
+*Potos flavus* (*P. caudivolvulus*)	Hunter 1861. Macalister 1867.
+*Nasua rufa* or *narica*	Hunter 1861.
+*Bassaricyon gabbi* (*B. alleni*)	Beddard 1900a.
+*Ailurus fulgens*	Flower 1870.
+*Acluropoda melanoleuca*	47432.
Ursidae	
+*Ursus arctos*	Hunter 1861. Macalister 1867.
+*Ursus maritimus*	Crisp 1862.
+*Ursus malayanus*	Rex 1888.
+*Melursus ursinus* (*Ursus labiatus*)	Flower 1872.
Mustelidae	
+*Mustela putorius* (*Putorius furo*)	Macalister 1867.
+*Mustela erminea* (*Putorius*)	
+*Mustela vison*	Gorham 1936.
+*Mellivora sagulata*	Hunter 1861.
+*Taxidea taxus* (*Meles labradoria*)	
+*Meles meles* (*M. taxus*)	
+*Martes martes* (*Mustela*)	
+*Martes pennanti* (*Mustela canadensis*)	Martin 1833b.
+*Mydaus marchei* (*M. meliceps*)	Hunter 1861.
+*Grison vittata* (*Mustela grison vittatus*)	
+*Tayra barbara* (*Galera*)	Crisp 1862.
+*Helictis subaurantiaca*	Garrod 1879c.
+*Helictis personata*	Beddard 1905a.
+*Lutra lutra* (*L. vulgaris*)	Hunter 1861. Crisp 1862.
+*Gulo* sp. (*Ursus gulo*)	Crisp 1862.
Viverridae	
+*Viverra zibetha*	Hunter 1861.
+*Viverra civetta*	Mivart 1882.
+*Suricata suricata* (*S. tetradactyla*)	Hunter 1861. Owen 1831b.
+*Paguma larvata* (*Paradoxurus*)	Mivart 1882.
+*Nandinia binotata*	Carlsson 1900.
−*Nandinia binotata*	Mivart 1882.
+*Crossarchus obscurus*	Martin 1834.
+*Arctictis binturong*	Garrod 1873a.
+*Hemigalus derbyanus*	Mivart 1882.
+*Galidea elegans*	Beddard 1909a.
+*Herpestes* sp.	Mivart 1882.
+*Prionodon* sp.	
+*Cryptoprocta ferox*	Beddard 1895.
Hyaenidae	
+*Hyaena brunnea*	Murie 1867.
+*Hyaena vulgaris*	Hunter 1861.
+*Crocuta crocuta* (*Hyaena*)	Watson and Young 1879a.
+*Proteles cristata*	Flower 1869.

TABLE 10—*Continued*

Carnivora (*continued*)	
Felidae	
+*Felis domestica*	Mivart 1881
+*Felis pardalis* +*Felis nebulosa* (*F. macrocelus*)	Crisp 1862
+*Panthera leo* (*Felis leo*)	Hunter 1861. Mentzer 1929.
+*Panthera pardus* (*Felis leopardus*)	Hunter 1861.
+*Panthera pardus* (*Felis pardus*)	Mentzer 1929.
+*Panthera onca* (*Felis*)	Martin 1832.
+*Lynx caracal* (*Felis*)	Hunter 1861.
+*Acinonyx jubata*	Mentzer 1929.
+*Felis concolor*	Martin 1833a.
Otariidae	
+*Eumetopias jubata* (*Otaria*)	Murie 1868.
+*Arctocephalus hookeri* (*Otaria*)	Murie 1867a.
Odobaenidae	
+*Odobaenus rosmarus* (*Trichechus*)	Murie 1870a.
Phocidae	
+*Phoca vitulina*	Hunter 1861 Flower 1872.
+*Phoca groenlandica*	Macalister 1867. Crisp 1862. Murie 1870b.

TABLE 11

Xenarthra	
Bradypodidae	
−*Bradypus tridactylus*	Hunter 1861. Burlet 1911.
−*Bradypus cuculliger* (*B. cuculli*)	Burlet 1911.
−*Bradypus griseus*	Wislocki 1928. Sonntag 1921a.
Choloepodidae	
+*Choloepus didactylus* (*Bradypus*)	Hunter 1861. Rapp 1852. Burlet 1911. Sonntag 1921a.
+*Choloepus hoffmani*	Wislocki 1928.
Myrmecophagidae	
+*Myrmecophaga jubata*	Owen 1854.
+*Cyclopes didactylus* (*Cyclothurus*)	Burlet 1911. Flower 1872. Wislocki 1928.
+*Tamandua* sp.	Wislocki 1928.
+*Tamandua tetradactyla*	Beddard 1909.
Dasypodidae	
+*Dasypus novemcinctus*	Hunter 1861. Crisp 1862. Rapp 1852.
+*Dasypus novemcinctus* (*D. peba*)	Owen 1831a.
+*Euphractus sexcinctus* (*Dasypus*)	Owen 1831c. Crisp 1862.
+*Tolypeutes tricinctus*	Garrod 1878.
+*Tolypeutes* sp.	Murie 1872a.
+*Chlamydophorus truncatus*	Macalister 1873.
Pholidota	
Manidae	
+*Manis pentadactyla*	Hunter 1861. Flower 1872.
+*Smutsia temminckii* (*Manis*)	Peters 1852.
+*Manis javanica*	Adams 1859.

TABLE 11—*Continued*

Tubulidentata	
Orycteropidae	
+*Orycteropus afer* (*O. capensis*)	Jaeger 1837. Sonntag 1925.
+*Orycteropus afer* (*O. afra*)	Fox 1930.

TABLE 12

Artiodactyla	
Tayassuidae	
−*Pecari torquatus* (*Dicotyles*)	Hunter 1861. Macalister 1867.
Suidae	
+*Babirussa alfurus* (*B. babirus*)	Flower 1872.
+*Phacochoerus africanus*	Mentzer 1929.
+*Phacochoerus aethiopicus* (*P. pallasii*)	Owen 1851.
Hippopotamiidae	
+*Hippopotamus amphibius*	Garrod 1879b. Weissberg 1932. Chapman 1881.
−*Hippopotamus amphibius*	Chapman 1881.
Camelidae	
−*Camelus bactrianus*	Flower 1872.
−*Lama guanicoe* (*L. pacos*)	Crisp 1862.
−*Lama vicugna* (*Auchenia* sp.)	
Tragulidae	
+*Tragulus kanchil*	Hunter 1861.
+*Tragulus javanicus* (*T. napu*)	Macalister 1867.
+*Dorcatherium aquaticum* (*Hyomoschus aquaticus*)	Flower 1867.
Cervidae	
+*Cervus axis*	Crisp 1862.
−*Cervus axis*	Hunter 1861. Raven 1936.
−*Cervus unicolor unicolor* (*C. hippelaphus*)	Crisp 1862.
−*Cervus unicolor moluccensis* (*C. moluccensis*)	
−*Cervus unicolor swinhoii* (*C. swinhoii*)	Garrod 1877.
−*Cervus unicolor marianus* (*C. mariannus*)	
−*Cervus elaphus*	
−*Cervus kukulii*	
−*Cervus timoriensis* (*C. molucensis*)	
−*Cervus duvauceli*	
−*Cervus alfredi*	
−*Cervus porcinus*	
+*Mazama superciliaris* (*Cervus*)	Crisp 1862.
−*Mazama rufus* (*Cervus*)	Garrod 1877.
−*Odocoileus hemionus* (*Cervus auritus*)	Crisp 1862. Gorham 1936.
−*Odocoileus mexicanus* (*Cervus*)	Crisp 1862.
−*Alces alces* (*Cervus*)	
−*Alces alces* (*A. machlis*)	Watson and Young 1879.
−*Muntiacus muntjac* (*Cervulus*)	Garrod 1877.
−*Muntiacus reevesi* (*Cervulus reevesi*)	
−*Hydropotes inermes*	Garrod 1877a.
−*Pudu pudu* (*Cervus*)	Garrod 1877.
−*Pudu pudu*	Flower 1875.
−*Elaphodus cephalophus*	Garrod 1877.
−*Elaphodus cephalophus* (*Lophotragus michianus*)	
−*Blastoceros bezoarticus* (*Cervus campestris*)	
+*Moschus moschiferus*.	Garrod 1877. Crisp 1862. Flower 1875.

TABLE 12—*Continued*

<table>
<tr><td>Artiodactyla (continued)</td><td></td></tr>
<tr><td>Giraffidae</td><td></td></tr>
<tr><td>†+Giraffa camelopardalis</td><td>Owen 1838b.
Gardon 1787.</td></tr>
<tr><td>−Giraffa camelopardalis</td><td>Owen 1838b.
Crisp 1862.
Neuville 1914.
Murie 1872c.
Chapman 1875a.
Joly and Lavocet 1845.</td></tr>
<tr><td>−Giraffa camelopardalis (Camelopardalis giraffa)</td><td>Garrod 1877.
Fox 1929.</td></tr>
<tr><td>−Giraffa reticulata</td><td>Lönnberg 1912.</td></tr>
<tr><td>Antilocapridae</td><td></td></tr>
<tr><td>+Antilocapra americana</td><td>Murie 1870b.
Lönnberg 1909.</td></tr>
<tr><td>Bovidae</td><td></td></tr>
<tr><td>Bovinae</td><td></td></tr>
<tr><td>+Bos taurus</td><td rowspan="2">Hunter 1861.</td></tr>
<tr><td>+Bison bison (B. americanus)</td></tr>
<tr><td>+Syncerus caffer (Buffelus c. radcliffei)</td><td>Mentzer 1929.</td></tr>
<tr><td>Caprinae</td><td></td></tr>
<tr><td>+Ovis musimon</td><td>Crisp 1862.</td></tr>
<tr><td>+Capra hircus (C. picta)</td><td>Garrod 1877.</td></tr>
<tr><td>*−Capra angoriensis (3 specimens)</td><td>Crisp 1862.</td></tr>
<tr><td>+Hemitragus jemlahicus (Capra jemlaica)</td><td>Garrod 1877.</td></tr>
<tr><td>Rupicaprinae</td><td></td></tr>
<tr><td>+Rupicapra rupicapra</td><td>Rex 1888.</td></tr>
<tr><td>+Budorcas taxicolor</td><td>Lander 1919.</td></tr>
<tr><td>Ovibovinae</td><td></td></tr>
<tr><td>+Ovibos moschatus</td><td>Lönnberg 1900.</td></tr>
<tr><td>Bubalinae</td><td></td></tr>
<tr><td>−Bubalis buselaphus (Antelope)</td><td rowspan="2">Crisp 1862.</td></tr>
<tr><td>−Damaliscus pygargus (Antelope)</td></tr>
<tr><td>+Damaliscus pygargus (Damalis)</td><td>Garrod 1877.</td></tr>
<tr><td>+Connochaetes albojubatus</td><td>Mentzer 1929.</td></tr>
<tr><td>+Connochaetes gnu (Catoblepas)</td><td>Garrod 1877.</td></tr>
<tr><td>Cephalophinae</td><td></td></tr>
<tr><td>−Cephalophus maxwelli (Antelope)</td><td>Crisp 1862.
Garrod 1877.</td></tr>
<tr><td>−Cephalophus monticola (C. pygmaeus)</td><td>Garrod 1877.</td></tr>
<tr><td>−Cephalophus harveyi keniae</td><td>Lönnberg 1900.</td></tr>
<tr><td>−Cephalophus melanorrhaeus</td><td>Lönnberg 1909.</td></tr>
<tr><td>−Cephalophus natalensis</td><td rowspan="2">Lönnberg 1900.</td></tr>
<tr><td>−Cephalophus abyssinicus hindei</td></tr>
<tr><td>−Cephalophus grimmia (Antelope mergens)</td><td>Crisp 1862.</td></tr>
<tr><td>−Cephalophus ogilbyi</td><td>Lönnberg 1900.
Lönnberg 1909.</td></tr>
<tr><td>Oreotraginae</td><td></td></tr>
<tr><td>+Ourebia nigricaudatus (Nanotragus)</td><td>Garrod 1877.</td></tr>
<tr><td>+Raphicerus campestris (R. neumanni)</td><td>Lönnberg 1909.
Mentzer 1929.</td></tr>
<tr><td>+Neotragus pygmaeus</td><td>Pocock 1918.</td></tr>
<tr><td>+Rhyncotragus cavendishi (R. kirkii)</td><td>Mentzer 1929.</td></tr>
</table>

† Six males, three females, others unsexed.

* Communication with breeders of Angora goats, in this country and abroad, failed to reveal any breed in which the gall bladder was absent. The number of specimens indicates that Dr. Crisp probably was guilty of mis-statement, rather than dissection of anomalous specimens.

TABLE 12—*Continued*

Artiodactyla (*continued*)	
Bovidae (*continued*)	
Reduncinae	
+*Reduncа arundinum* (*Antelope isabelliana*)	Crisp 1862.
+*Kobus defassa*	Mentzer 1929.
+*Kobus ellypsiprymnus*	Smith 1849.
Saiginae	
+*Saiga tartarica*	Murie 1870c.
Antelopinae	
+*Antelope cervicapra* (*A. bezoartica*)	Crisp 1862.
+*Gazella dorcas* (*Antelope*)	Crisp 1862. Garrod 1877.
+*Gazella bennetti* (*Antelope*)	Crisp 1862.
+*Gazella granti*	Mentzer 1929. Garrod 1877.
+*Gazella subgutturosa* +*Gazella muscatensis* +*Gazella rufifrons* +*Gazella arabica*	Garrod 1877.
+*Antidorca marsupialis* (*Antelope euchore*)	Crisp 1862.
+*Lithocranius walleri*	Lönnberg 1900.
Oryginae	
+*Oryx leucoryx* (*Antelope*)	Crisp 1862.
+*Addax naso-maculatus*	Crisp 1862. Garrod 1877.
Tragelaphinae	
+*Tragelaphus scriptus* (*Antelope*)	Crisp 1862. Garrod 1877.
+*Strepsicerus strepsicerus* (*S. Kudu*)	Garrod 1877.
+*Taurotragus oryx*	Mentzer 1929.
+*Taurotragus oryx* (*Antelope oreas*)	Crisp 1862.
+*Taurotragus oryx* (*Oreas caana*)	Garrod 1877.
+*Boselaphus tragocamelus* (*Antelope picta*)	Hunter 1861.
+*Boselaphus tragocamelus* (*Portax picta*)	Garrod 1877.
+*Limnotragus gratus* (*Tragelaphus gratus*)	Neuville 1897.
+*Tetracerus quadricornis* (*T. subquadricornatus*)	Garrod 1877.

TABLE 13

Sirenia	
Trichecidae	
+*Trichecus manatus* (*Manatee americanus*)	Murie 1870.
+*Trichecus manatus* (*Manatus inunguis*)	Beddard 1897.
+*Trichecus manatus* ("Manatee")	Chapman 1875.
Dugongidae	
+*Dugong australis* (*Halicore* sp.)	Owen 1838a.
Rhytinidae	
−*Rhytina stelleri*	Steller 1749.
Hyracoidea	
Procariidae	
+*Procavia capensis*	Owen 1832. Macalister 1867. Mentzer* 1929.
−*Procavia capensis*.	Raven 1936. Crisp 1862. Flower** 1872. Huxley 1872. Martin 1835.

*Mentzer examined two specimens, one with a gall bladder filled with liver flukes. He notes that the gall bladder, with a central and two lateral sacs, as reported by Owen and Macalister, may be found only as a dilation or a lateral pouch of the common duct, at the point where the four hepatic ducts join it.

**Flower says that this animal has no gall bladder, but in some specimens the common duct is dilated to great size.

TABLE 13—*Continued*

Proboscidea	
Elephantidae	
—*Elephas maximus* (*E. indicus*)	Hunter 1861. Crisp 1862. Forbes 1879.
—*Loxodonta africana* (*Elephas africanus*)	Forbes 1879.
—"Elephant"	Eales 1929. Chapman 1875b.

TABLE 14

Perissodactyla	
Tapiridae	
—*Tapirus terrestris* (*T. americanus*)	Crisp 1862.
—*Tapirus indicus*	Parker 1882.
—*Tapirus indicus*	Murie 1871b.
Rhinocerotidae	
—*Rhinoceros unicornis*	Beddard 1887. Owen 1850.
—*Rhinoceros sumatrensis* (*Ceratorhinus*)	Garrod 1873.
Equidae	
—*Equus caballus* / —*Equus asinus* / —*Equus zebra*	Hunter 1861.
—*Equus burchelli*	44391.
—*Equus quagga*	Mentzer 1929.

TABLE 15

Cetacea	
Mysticeti	
Balaenidae	
—*Balaena mysticetus*	Hunter 1840.
Balaenopteridae	
—*Balaenoptera acutirostrata* (*B. rostrata*)	Hunter 1861. Eschricht 1849.
—*Megaptera longimana* (*M. boops*)	Carte and Macalister 1868. Eschricht 1849.
Odontoceti	
Platanistidae	
—*Platanista gangetica*	Anderson 1879.
Physeteridae	
—*Physeter catodon* (*P. macrocephalus*)	Hunter 1840.
Ziphiidae	
—*Ziphiorrhynchus cryptodon*(?)	Burmeister 1866.
—*Hyperoodon ampullatus* (*Delphinus bidens*)	Hunter 1861.
Delphinapteridae	
—*Delphinapterus leucas* (*Belugia catodon*)	Hepburn and Waterson 1901.
—*Monodon monoceros*	Hunter 1840. Turner 1899.
Delphinidae	
—*Neophocaena phocaenoides* (*Neomeris*)	Chi Ping 1926.
—*Phocaena phocaena* (*Delphinus*)	Hunter 1840.
—*Phocaena phocaena* (*P. communis*)	Huxley 1872. Hepburn and Waterson 1901.
—*Orca gladiator* (*Delphinus orca*)	Turner 1899.
—*Orcella brevirostris* (*Orcella*)	Anderson 1879.
—*Globiocephalus melaena* (*G. melas*)	Gulliver 1853. Turner 1868. Murie 1873. Weissberg 1932a.

TABLE 15—*Continued*

Cetacea (*continued*)	
Odontoceti (*continued*)	
Delphinidae (*continued*)	
−*Lagenorhynchus albirostris*	Weissberg 1932a.
−*Delphinus delphis*	Weissberg 1932a.
−*Tursiops truncatus* (*Delphinus tursio*)	Hunter 1861.
−*Tursiops truncatus* (*T. tursio*)	Weissberg 1932a.
−*Grampus griseus*	Weissberg 1932a.
+*Gramphidelphis risii* (*Globiocephalus risii*)	Williams 1838.
−*Gramphidelphis risii* (*Grampus rissoanus*)	Murie 1871b.

TABLE 16

Rodentia	
Aplodontiidae	
−*Aplodontia rufa*	Hall, MVZ 22623.
Sciuridae	
+*Sciurus vulgaris*	Crisp 1862. Rex 1888. Cuvier 1835.
−*Sciurus carolinensis*	Crisp 1862.
+*Sciurus carolinensis* (*S. cinereus*)	Hunter 1861.
−*Sciurus indicus* (*S. maximus*)	Cuvier 1835. Crisp 1862.
+*Tamias striatus*	15440. 15442.
+*Marmota marmota* (*Arctomys*)	Hunter 1861.
+*Marmota marmota* (*Arctomys alpinus*)	Crisp 1862. Macalister 1867.
+*Marmota monax* ("Marmottes de canada")	Cuvier 1835.
+*Citellus tridecemlineatus*	Higgins 1928.
+*Citellus suslicka* ("Spermophile souslick")	Cuvier 1835.
+*Glaucomys volans* (*Pteromys volucella*)	Yarrell 1831a.
+*Glaucomys volans* (*Sciuropterus volucella*)	Hunter 1861.
+*Glaucomys volans* (*Sciurus volucella*)	Crisp 1862.
+*Glaucomys volans* ("Hassapan")	Cuvier 1835.
−*Petaurista petaurista* ("Le grand ecruil volant de Java")	Cuvier 1835.
Castoridae	
+*Castor fiber*	Macalister 1867. Crisp 1862.
+*Castor canadensis*	Hunter 1861.
Heteromyidae	
−*Perognathus fallax*	16190.
Geomyidae	
−*Thomomys bottae*	Gorham 1936.
−*Geomys bursarius*	Gorham 1936.
Anomaluridae	
+*Anomalurus pelii*	Alston 1875.
+*Anomalurus fraseri*	Alston 1875.
Pedetidae	
−*Pedetes caffer*	Parsons 1898.
−*Pedetes caffer* (*Helamys capensis*)	Hunter 1861.
−*Pedetes caffer* (Forster's jerboa)	Cuvier 1835.
Myoxidae	
+*Muscardinus avellenarius*	Cuvier 1835. Macalister 1867.
+*Glis glis* ("loir")	Cuvier 1835.
+*Glis nitedula* (?) ("lerot")	Cuvier 1835.
Dipodidae	
+*Dipus saggita*	Hunter 1861. Macalister 1867. Duvernoy and Lereboullet 1840.

TABLE 16—*Continued*

Rodentia (*continued*)	
Dipodidae (*continued*)	
+*Dipus gerboa* (*D. mauritanicus*)	Duvernoy and Lereboullet 1840.
+*Jaculus loftusi*	42459.
+*Zapus hudsonius*	18804.
+*Zapus hudsonius* (*Dipus americanus*)	Cuvier 1835.
Spalacidae	
+*Myotalpa aspalax* (*Siphneus myospalax*)	Milne-Edwards 1874.
+*Spalax* sp.	Macalister 1867.
+*Spalax typhlus* (*Mus*)	Cuvier 1835.
+*Rhizomys badius*	Anderson 1879.
+*Rhizomys pruinosus*	
Muridae	
Cricetinae	
−*Cricetus cricetus*	Macalister 1867.
−*Cricetus cricetus* ("Hamster")	Cuvier 1835.
−*Cricetulus migratorius* (*Mus atticus*)	
−*Cricetulus migratorius* (*Mus accedula*)	
−*Cricetulus migratorius* (*Mus phaeus*)	
−*Criceliscus sungarus* (*Mus*)	
*−*Reithrodontomys longicauda*	16173.
+*Peromyscus leucopus*	15484.
Lophiomyinae	
−*Lophiomys* sp.	Flower 1872.
Microtinae	
+*Arvicola amphibia*	Macalister 1867. Hunter 1861.
+*Dicrostonyx richardsonii* ("Lemming de la baie d'Hudson")	Cuvier 1835.
+*Ellobius talpinus* (*Mus*)	
+*Ondatra zibethicus* ("Ondatra")	
+*Ondatra zibethicus* ("Desman")	Hunter 1861.
+*Microtus ochrogaster*	15486.
Murinae	
−*Rattus norvegicus* (*Mus decumanus*)	Hunter 1861.
+*Pelomys fallax*	Peters 1852.
+*Mus musculus*	Crisp 1862. Hunter 1861.
+*Leggada bellus* (*Mus minimus*)	Peters 1852.
−*Apodemus agrarius* (*Mus*)	Cuvier 1835.
−*Micromys minutus* (*Mus*)	
+*Steatomys pratensis* (*S. edulis*)	Peters 1852.
+*Arvicanthis abyssinicus*	21302.
+*Arvicanthis barbarus* (*Mus*)	Duvernoy and Lereboullet 1840.
−*Otomys nyikae*	21274.
+*Otomys brantsii* (*Euryotis*)	Smith 1849.
Gerbillinae	
+*Meriones shawi* ("Gerbille de Shaw")	Cuvier 1835.
+*Meriones shawi* (*Gerbillus shawii*)	Duvernoy and Lereboullet 1840.
+*Gerbillus pygargus* ("Gerbille du Senegal")	Cuvier 1835.
+*Tatera leucogaster* (*Meriones*)	Peters 1852.
Hydromyinae	
−*Hydromys chrysogaster*	Windle 1887.
Bathyergidae	
+*Myoscalops argenteo-cinereus*	Peters 1852.
+*Bathyergus* sp.	Hunter 1861.
+*Georychus capensis* (*Orycterus*)	

* In one of four individuals the organ was present.

TABLE 16—*Continued*

Rodentia (*continued*)	
Hystricidae	
—*Hystrix cristata*	Parsons 1894.
+*Hystrix cristata*	Macalister 1867. Hunter 1861. Lesbre 1907.
+*Hystrix cristata* ("*Porc-epic*")	Cuvier 1835.
—*Hystrix africaeaustralis*	Peters 1852.
+*Acanthion javanicum* (*Hystrix javanica*)	Parsons 1894. Mivart 1882a.
Erethizontidae	
—*Erethizon dorsalis*	Mivart 1882a.
—*Coendou prehensilis* (*Hystrix*)	Macalister 1867. Cuvier 1835.
Dasyproctidae	
+*Dasyprocta aguti*	Macalister 1867. Crisp 1862. Jones 1834.
+*Dasyprocta antillensis* or *albida* (*D. cristata*)	Mivart and Murie 1866.
+*Myoprocta acouchy* (*Dasyprocta*)	Owen 1831. Hunter 1861.
Caviidae	
+*Cavia porcellus*	Hunter 1861. Macalister 1867. Higgins 1927.
+*Hydrochoerus hydrochaeris* (*H. capybara*)	Stark 1934. Macalister 1867. Hunter 1861. Crisp 1862.
+*Cuniculus paca* (*Coelogenys*)	Hunter 1861.
+*Cuniculus subniger* (*Coelogenys*)	Martin 1838a.
+*Dolichotis patagonica*	Beddard 1891.
Chinchillidae	
+*Chinchilla laniger*	Bennet 1833.
+*Lagidium viscaccia* (*Lagotis cuvieri*)	Bennet 1833.
+*Lagidium viscaccia* (*Lagostomus trichodactylus*)	Owen 1839.
Capromyidae	
+*Capromys pilorides* (*Isodon*)	Say 1822.
+*Capromys pilorides* (*C. fournieri*)	Owen 1832b. Cuvier 1835.
+*Capromys melanurus*	Kuhl 1820. Dobson 1884.
Octodontidae	
+*Octodon degus* (*O. cumingii*)	Martin 1836b.
—*Echimys* sp.	Cuvier 1835.
+*Pectinator spekii*	Peters 1871.
+*Ctenomys torquatus*	44813.
+*Myocastor coypus* (*Myopotomus*)	Martin 1835c.
Ctenodactylidae	
+*Ctenodactylus gündi* (*C. massonii*)	Yarrell 1831.
Petromyidae	
*—*Petromys typicus*	Smith 1849.
Thryonomyidae	
+*Thryonomys swinderianus* (*Aulacodus*)	Garrod 1873b.
Leporidae	
+*Lepus timidus*	Crisp 1862. Hunter 1861.
+*Lepus californicus*	Gorham 1936.
+*Oryctolagus cuniculus* (*Lepus*)	Hunter 1861.
Ochotonidae	
+*Ochotona princeps*	MVZ 22913.

* Smith figures the liver. No gall bladder is shown. He offers no discussion.

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A NEW CATALOGUE
OF THE
FRESH-WATER FISHES OF PANAMA

BY

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CONTENTS

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BY SAMUEL F. HILDEBRAND

INTRODUCTION

The present paper embodies the results of a study based mainly on specimens and data collected by the writer in 1935 and 1937. This study was supplemented by information gained from the examination of small collections made by others. Furthermore, some of the material collected in 1911 and 1912 by the late Dr. Seth E. Meek and the writer, was re-examined for further information.

The Fishes of the Fresh Waters of Panama by Seth E. Meek and the writer, published by Field Museum in 1916, has been drawn upon freely. The present paper is intended to supplement this earlier general work. Errors in that publication have been pointed out, descriptions have been emended if necessary, and in some instances new keys have been given to include species since recorded. All the species described in the earlier work are mentioned in the present one, together with such additional information as seems worthy of record, including the up-to-date knowledge of distribution. Descriptions, or at least sufficient information for identification of species not included in the general account of 1916, are given in the present paper. In the synonymy only the names used by the original describers are given, together with a reference to our earlier general work; if not included therein a reference to other writers who have recorded the species from Panama is included.

The principal papers on fresh-water fishes of Panama, that have appeared since 1916 are *The Fishes of the Rio Chucunaque Drainage, Eastern Panama,* by C. M. Breder, Jr. (1927), and *A List of the Fresh Water Fishes of Western Panama between Long. 81° 45′ and 83° 15′ W.,* by Dr. Ellinor H. Behre (1928). These reported a considerable number of species previously not recorded from Panama. Several smaller papers have appeared, and are referred to in appropriate places in the accounts of species, and are listed in the "References." Unfortunately, comparatively few of the specimens on which these later papers were based have been available to me for examination.

The number of species reported from the fresh waters of the Republic in our earlier (1916) work has been increased from 94 to 127.

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A further increase is expected, as most of western Panama, and a considerable part of the Atlantic slope of eastern Panama remain ichthyologically virtually unexplored.

The designations western, central, and eastern Panama are used freely in this paper. It is understood, of course, that there are no such political divisions. As here used western Panama includes the states of Bocas del Toro and Chiriquí, while central Panama includes the Canal Zone and the territory westward on the Pacific slope a distance of about 70 miles. The Atlantic slope west of the Canal Zone is not included because no collections have been made there, except at Bocas del Toro, which is included in western Panama. Eastward, central Panama includes the territory as far as Porto Bello on the Atlantic and the Bayano Basin on the Pacific. Eastern Panama consists principally of the Tuyra Basin, including two large rivers, the Tuyra and the Chucunaque. The narrow Atlantic slope from Porto Bello to the Colombian border remains virtually unexplored.

Only those species which live more or less constantly in fresh water are included. A few, such as some of the Gobiidae (now usually placed in a separate family, Eleotridae), and a few of the Poeciliidae, descend to brackish water. On the other hand, several species belonging to marine families, which dwell in the fresh water of Panama more or less commonly, such as one of the Syngnathidae (*Doryrhamphus lineatus*), one of the Atherinidae (*Menidia chagresi*), several species of Centropomidae, the tarpon, and several others, are not included. These will be dealt with mostly in a paper now in preparation, pertaining to the use of the Panama Canal and its locks as a passageway for fishes.

Two papers (Hildebrand, 1935 and 1937) based on these investigations have been published. It is proposed also to publish one or more papers on extensive collections of marine fishes made on both coasts of Panama, and the Pearl Islands, wherein species ranging into fresh water probably will be dealt with still further. It may be added that marine fishes have invaded the fresh water of the Canal to a remarkable degree.

The order of families, genera, and species used in our earlier work has been retained as far as practicable. Only such changes in nomenclature as seemed well founded have been made. Wherever recently proposed changes in nomenclature of families and genera have not been followed the reasons are stated.

The proportions and counts given were derived by the same methods as in the earlier work. It seems sufficient to state only that the scale counts, unless otherwise stated, show the number of oblique series of scales (running upward and backward) crossing a straight line between the upper anterior angle of the gill opening and the base of the caudal. The counts in Arabic numerals of soft rays of the fins include undivided or rudimentary rays, unless otherwise stated. Definitely developed spines are always given in Roman numerals.

NOTES ON THE ORIGIN AND DISTRIBUTION OF PANAMA FISHES

It was pointed out in our earlier work that the fresh-water fishes of Panama, known at that time, when western Panama remained unexplored, were chiefly of South American origin. Principally through the work of Dr. Behre (1928) it has since been learned that the fish fauna of western Panama is composed largely of Central American forms. In fact, comparatively few of the species of central Panama have been taken in western Panama.

The Loricariidae, with one exception (*Plecostomus plecostomus panamensis*), apparently do not reach western Panama, though seven species, some of which are common, are found in central Panama.

The Characinidae are much less numerous in western than in central Panama, and the species found there are largely different. Only nine species are known from western Panama, whereas 32 are reported in this paper from central and eastern Panama, and only two (possibly three) are common to both regions.

It is evident, then, that the Loricariidae and the Characinidae, two large and rather typical South American families of fresh-water fishes, mostly reach the northern (western) limits of their range in central Panama. A similar distribution, that is, dissimilarity of species, exists among other families, though perhaps less clearly.

On the other hand, the family Cichlidae, which is more numerous in Central than in South America, has a larger number of representatives in western than in central Panama, there being 11 species recorded from the first-mentioned region and six (two of which are doubtful) from the last-mentioned one. Three (possibly four) are common to both regions.

Because of the unexplored intermediate territory, it cannot yet be stated where the Central American fauna ends and the South American one begins, if in fact a definite division exists.

Meager data suggesting a crossing over from the Atlantic to the Pacific slope in western Panama were obtained. This crossing over is suggested by three species of characins; namely, *Brycon obscurus*, taken at El Valle, and *Brycon behreae* and *Roeboides guatemalensis*, in the vicinity of Caldera. The specimens upon which Behre (1928, p. 318) based the Caldera record of the last-named species were not seen by me. The other two, described herein as new, are extremely closely related to Atlantic slope (Chagres River) forms, and rather remotely to species found east of El Valle. *Bryconamericus zeteki* from El Valle, here described as new, is very closely related to *B. emperador*, which occurs on both slopes in the vicinity of the Canal Zone, but apparently not at El Valle. *B. zeteki*, too, may have reached this locality from the Atlantic slope, as the indications are that the Pacific slope characins of central Panama have not reached El Valle.

According to the most authentic information obtainable, the two streams sampled in El Valle, a small, flat area supposedly the crater of an extinct volcano, are both branches of the Antón River, a Pacific slope stream, though a small branch of the Rio Indio, a tributary of the Atlantic, cuts into El Valle. Evidently the streams of the opposite slopes approach each other closely in El Valle. Possibly with the aid of high water, or through volcanic action as suggested elsewhere, a transfer of fish from one slope to the other may have taken place here. Farther westward, where there is evidence of comparatively recent volcanic action, further transfers may have occurred.

It is interesting that such common species of characins of the Pacific slope of central Panama as *Brycon striatulus*, *Brycon argenteus* and *Roeboides occidentalis* apparently do not occur in western Panama, and perhaps not even as far westward as El Valle, where an influx of Atlantic slope species apparently has taken place. The specimens listed as *Brycon striatulus* from western Panama by Behre (1928, p. 317) have been restudied and found to belong to an undescribed species here named *B. behreae*.

It is surprising that the exceedingly abundant characin, *Astyanax ruberrimus*, of both slopes of central Panama, was also missing at El Valle, though it was common near there in streams toward the Canal Zone side of a high ridge. Neither has this species been taken farther westward. A related species, recorded as this one by me (1928, p. 83) was secured in certain volcanic lakes, near Volcán, Chiriquí. Several differences were found, however, upon comparison

and careful study of specimens from central and western Panama. The Volcán material is apparently new and is named *Astyanax kompi*.

It is interesting that in my investigations in the Chiriquí Viejo Basin no native fish was found above an elevation of about 5,000 feet. Only *Brachyraphis terrabensis* was found, at altitudes of about 4,800 to 5,000 feet. Down to about 4,200 feet, below which no collections were made, *Rhamdia rogersi* and many *Brachyraphis terrabensis* were taken. *Agonostomus* was seen, but not captured. In lakes Gulnar and Grande, which supposedly occupy the craters of extinct volcanoes, situated at an elevation of about 4,500 feet, *Brachyraphis terrabensis* and *Astyanax kompi* were numerous, and *Rivulus volcanus* was common. The last-named, also, is described here as new.

It might be supposed that the rainbow trout had eradicated the native species in the upper stretches of the Rio Chiriquí Viejo. However, in Puerto Rico, where no introductions had been made in most of the streams examined, the writer (1935) found few or no fishes above an elevation of 1,500 to 2,000 feet, the species apparently being unable to penetrate the colder water of the upper stretches of the streams. It seems probable that a similar situation prevails in the Rio Chiriquí Viejo.

The relationship of the fishes of the Chagres Basin and opposing Pacific slope streams, including the Bayano, were discussed in the introduction to our earlier work. There is little to be added. As pointed out previously, the species of the opposite slopes in central Panama are very similar. Some differ in minor, but apparently constant, characters. Others remain identical. Yet it is undoubtedly correct to say that the fishes of the opposite slopes of central Panama are more dissimilar; that is, they have "drifted" farther apart, morphologically, than the fishes of the Pacific slope of eastern Panama and the Atlantic slope of Colombia. In other words, the fishes of the Tuyra Basin and those of the Atrato and Magdalena basins are more closely related, morphologically, than the fishes of the Chagres Basin and the opposing Pacific slope streams. A greater difference exists, however, between the fishes of the Chagres and those of the Atrato and Magdalena.

Although the number of identical species occurring in different streams is not an absolute criterion of the relationship of the faunas, yet it seems rather significant. Accordingly the following numbers are presented, in which the fresh and brackish water gobies with separate ventrals, that is, the Eleotridae, are omitted because they are not

strictly fresh-water fishes. Several doubtful records of fishes of other families are also excluded. After these exclusions have been made, there remain records of 21 species common to both slopes of central Panama, and 37 that inhabit only one slope. Comprising the latter are 16 from the Atlantic and 21 from the Pacific slope.

Breder (1927) discussed the relationship of the fishes of the Bayano and Tuyra basins. As no new collections have been made in these rivers Mr. Breder's remarks stand substantially as reported. There are listed in these pages 32 species common to the basins of these streams, as compared with 18 species common to the Bayano and the Chagres basins. Breder pointed out the apparently close approach of the upper branches of the Bayano and the Chucunaque, and the possibility of a recent connection. The rather large number of identical species seems to show that a comparatively recent passageway for fishes existed.

The relationship of the fishes of the Tuyra and the Atrato basins was discussed briefly in our earlier work. Since that time Eigenmann (1920) has given it further attention. In the present paper 26 species are listed from the Tuyra, which Eigenmann (1922) also listed from the Atrato and the Magdalena. The close approach of the upper tributaries of the Atrato and the Tuyra was pointed out in our earlier work. That the Indians to the present time drag their wooden dugouts across the divide was confirmed recently by an eye-witness. It is not surprising, therefore, that a considerable number of species in the two streams are identical, or at least closely related. It is interesting that only 18 of the 57 species listed from the Tuyra Basin are recorded from the Pacific slope of Colombia.

It has been stated elsewhere that the fishes of the Chagres Basin differ rather more widely from those of the Atrato and the Magdalena basins than from those of the Tuyra. In partial confirmation it may be stated that 12 identical species are listed from the Chagres and the Atrato and Magdalena basins, whereas 17 identical species are recorded from the Chagres and the Tuyra basins.

The information gained since our earlier work was printed, then, seems to show more clearly that most of the fishes of eastern and central Panama are of South American origin. The principal route of migration apparently was from the Atlantic slope of Colombia to the Pacific slope of eastern and central Panama. The most probable route is from the Atrato to the Tuyra; from the Tuyra to the Bayano; and from the Bayano and neighboring coastal streams to the Chagres. The slight information suggesting a "re-recrossing" in western Panama

has already been stated. The fishes of far western Panama, however, are chiefly Central American.

I am pleased to quote from a letter by R. A. Terry, the geologist who has explored Panama extensively, findings that seem to be in agreement with the indicated connections of Atlantic and Pacific slope streams shown by the distribution and relationship of the fish faunas of various streams of Panama. In a sketch map Mr. Terry shows the close approach of the headwaters of the Tuyra and the Atrato rivers on the Panama-Colombia border. He says: "It seems likely that branches of the upper Tuyra have been pirated (cut into) by the Salaquí (an upper tributary of the Atrato), thus transferring Atrato fishes to the Tuyra . . . . Just when it took place I do not know, further than that it must have been subsequent to the late Pleistocene (or post-Pleistocene) elevation.

"A similar favorable stream piracy occurs between the heads of the Chillibrillo and the María Prieta just east of the Canal Zone, where limestone sinks occur almost on the continental divide, which is quite flat. These sinks might conceivably be shifted from one drainage to the other by the development of solution channels irrespective of the normal erosive power of the streams to which they drain.

"In the El Valle region the eruption which formed the El Valle volcanic crater with its surrounding walls must have been terminated earlier than the late Pleistocene, or post-Pleistocene time. I suspect that shifting of stream channels by this late vulcanism is responsible for the migration of species in this region, and also in the vicinity of Caldera, where the ejecta of the Chiriquí Volcano have obviously changed the drainage system of the region greatly."

INTRODUCTION OF FISHES

The first record of introduction which has been found, is contained in *Mosquito Control in Panama*, by J. A. Le Prince and A. J. Orenstein (1916, p. 185), where it is reported that *Girardinus poecillodes* (=*Lebistes reticulatus*) the "millions fish" or "guppy" was brought from Barbados. The date of introduction is not given, but in a recent letter Mr. Le Prince states that the fish were brought about 1910 or 1912. The few fish received were bred in captivity for a time; they multiplied rapidly; and batches were liberated in several places now included in Gatun Lake. As no specimens have been reported from Panama since the introduction was made, the species apparently failed to become established. It is highly prob-

able that some of the native species of viviparous top minnows, especially *Gambusia nicaraguensis*, *Brachyraphis episcopi*, and *Allogambusia tridentiger*, are even more useful for mosquito control. Mr. Le Prince, who was chief sanitary inspector for the Isthmian Commission from 1904 to 1914, knows of no other introductions of top minnows.

Upon the request of the Canal Zone authorities, at least two shipments of young fish, one in 1917 and another in 1925, have been made. The first shipment consisted of "450 large mouth bass, 1,000 catfish, and 800 sunfish." The second one contained "2,250 large mouth bass, 500 blue-gills and 500 crappies." The fish, according to a Canal Zone informant, were planted in Gatun Lake, at Gatun, immediately upon arrival. These plants apparently failed, as no specimens of the fish introduced were seen or taken during my visits in 1935 and 1937. The stray reports of the capture of bluegills and a crappie, such as was once reported in Fisheries Service Bulletin No. 182, 1925, may have resulted from misidentifications by the reporters. I was able to trace one such erroneous report. A certain Canal employe, who claimed that the bluegill had become established, without hesitancy identified *Cichlasoma maculicauda* as the bluegill, when specimens of this cichlid were placed before him.

The only introduction that has been a success, to date, is that of the rainbow trout, introduced into the Rio Chiriquí Viejo in western Panama, in 1925, through a shipment of eggs. The writer spent several days on this river, in 1935, between an elevation of about 4,500 and 7,000 feet. Above an altitude of about 5,000 feet the trout probably are as abundant as in any stream in the United States. At lower elevations the temperature is too high for trout. Trout-fishing in the high altitude, where the nights are always cool, if not cold, is giving enjoyable recreation to many Canal employees, as well as others, who visit there from time to time. An account of the status of this introduction, together with some records of temperature and foods utilized by the trout, was given by me (1935) in the Bulletin of the Pan-American Union. Inadvertently the number of eggs planted was stated as 2,500 in the article cited, whereas 25,000 eggs were actually sent.

No doubt rainbow trout would thrive in other mountain streams of western Panama, where the maximum temperature is 70° F. or less. It has been reported that an introduction in the vicinity of Boquete, presumably in the upper tributaries of the Rio Chiriquí, is beginning to yield returns.

At present the lakes of the Canal support few food and game fishes. The few that provide sport and food are mostly migrants from the sea, the most important one being the tarpon, as pointed out in my recent (1937) paper. There is no commercial fishery, worthy of the name. It does seem that such a fine large body of water as Gatun Lake, having an area of 196 square miles and a shore line about 1,100 miles long, should be more productive. The newly created Madden Lake, with an area of 18 square miles, apparently should support food and game fishes after the dense vegetation covered has decayed in part and settled.

The temperature of the lakes seemingly would not preclude some of the warm-water fishes of the United States, which have been introduced successfully in Puerto Rico, Cuba, and elsewhere. According to Canal records furnished through the courtesy of Mr. R. Z. Kirkpatrick, the minimum surface temperature of Gatun Lake during any one month from 1919 to 1936 inclusive, based on two daily readings, one at 8:00 A.M. and another at 2:00 P.M., was 80.9° F., which occurred during January, 1928. The maximum for readings, taken at the same time and place, was 86.2°, reached in June, 1930. The average yearly temperature, based on the same records, has fluctuated from 82.6° in 1927 to 84.8° in 1930. The indications are that the temperature of the recently formed Madden Lake will be only a few degrees lower than that of Gatun Lake. The cold of the northern winters and the heat of the summers are only very slightly reflected as far south as Panama.

The native river fishes of the vicinity do not seem to have become numerous in the lakes, exclusive of the small characin ("sardina"), *Astyanax ruberrimus*, which is exceedingly abundant. As this fish reaches a length of only about 75 mm. it is too small to be of direct value as food for man. If this fish could be utilized as food for larger fishes it might still be valuable. It is not evident just yet how that can be done without sacrificing the top minnows, which must be preserved, as shown subsequently.

In the endeavor to make the fresh waters of the Canal productive, the first step apparently should be an investigation of these waters and their animal and plant life, including a careful study of the life habits (especially breeding) of the native fishes. Introductions should be considered only after a careful study of the indigenous fishes has been made.

Three native species of fresh-water fishes would seem worthy of special study; namely, the two "sábalo pepons," *Brycon chagrensis*

and *B. petrosus*, and the "mojarra," *Cichlasoma maculicauda*. Although the sábalo pepons grow much larger, reaching a length of two feet or so, the mojarra, which resembles the bluegill superficially, and reaches a similar size, probably is the most promising. The last-mentioned species is already fairly common in Gatun and Miraflores lakes. Its food and game qualities, however, seem largely unknown.

Great care should be exercised as to introductions of food and game fishes, because the population of top minnows (Poeciliidae) in the lakes must be maintained for the purpose of mosquito and malaria control. Certainly such highly predatory fishes as the large mouth bass and the pikes and pickerels should not be introduced. Less destructive species, as for example, the bluegill sunfish and the bullhead catfish, might be considered. The introduction of carp has been suggested by Colonel H. C. Pilsbury, Chief Health Officer, who expressed the hope that it might become numerous enough to thin the plant growth and thereby aid the top minnows in destroying larval mosquitoes. The carp, of course, is not highly regarded as a food fish, and scarcely ranks as a game fish, though it can be caught on a hook with the use of vegetable baits. Once hooked, it puts up a good fight. It seems only remotely probable, however, that the carp would become abundant enough to make appreciable inroads on the very extensive plant growth present.

It may be remarked that it seems useless to attempt the further introduction of fry or fingerlings, as earlier attempts failed completely. It would seem necessary to introduce fish too large to be managed by the exceedingly abundant and highly predatory "sardina," *Astyanax ruberrimus*. Whether the introduced fishes could breed, even if they themselves survived, is problematical. It might be necessary to maintain hatcheries to keep the lakes stocked, which would be expensive if virtually no reproduction took place naturally. It is evident, then, from the foregoing that the establishment and the maintenance of food fishes in the artificial lakes of the Canal is a complicated matter which should receive further study.

NEW AND ABANDONED LOCALITIES

As many changes in local nomenclature have taken place in the Canal Zone, and in the Chagres Basin beyond the Canal Zone, since 1911 and 1912 when our previous collections were made, a brief explanation seems desirable. Several towns listed as collecting stations in our earlier work no longer exist. Some of these were abandoned because the ground on which they were situated was

flooded; others were not needed after the construction of the Canal had been completed; and a few became rather inaccessible through the flooding of the Canal and the relocation of the Panama Railroad. Names of a few new localities also appear in the present report.

As an aid to those who may use the earlier, as well as the present work, the changes are listed in the order they occur or occurred from the Atlantic terminus of the Canal southward. The changes in the Chagres Basin east of the Canal Zone also are discussed.

Toro Point, situated across Limón Bay from Colón and Cristobal, is now generally called Fort Sherman.

Mindi, formerly situated a short distance south of Mount Hope, no longer exists.

New Gatun has been replaced in approximately the same locality by Fort Wm. D. Davis. Gatun itself remains situated in its former location; namely, at the place where the Chagres River was dammed to form Gatun Lake.

Monte Lirio, formerly situated on the Rio Gatun, is now on an island in Gatun Lake, the river being almost wholly included in the lake.

Agua Clara, situated on the Rio Trinidad, a large tributary of the Rio Chagres west of the route of the Canal, was flooded and abandoned.

Bohio, situated on the route of the Canal, about 15 miles south of Gatun, came within the flooded area and had to be abandoned.

Barro Colorado Island is one of the new localities where collections were made during the present investigation. Formerly a high hill, it is now the largest island in Gatun Lake. It has been made a wild life preserve, and upon it is situated the laboratory of the Institute for Research in Tropical America. This island lies westward across Gatun Lake from the railway station, Frijoles.

Tabernilla, Gorgona and Bas Obispo, all along the direct route of the Canal and the Chagres River, were flooded and abandoned.

Gamboa, situated near Bas Obispo, was not used as a collecting station in 1911 and 1912. It is now one of the important stations on the Panama Railroad. In 1935 when collections were made in the upper end of Gatun Lake, it served as a collecting station. Accordingly, the name appears several times in the present catalogue.

Beyond Gamboa, and on the west side of the then proposed Canal, were situated the important towns, Empire and Culebra. The latter, at the summit of the divide, was the headquarters of the Isthmian

Canal Commission during the construction of the Canal. Though these places are shown on current maps they have virtually been abandoned, having became rather inacessible when the Panama Railroad was relocated on the east side of the Canal.

Summit is one of the new localities appearing in the present work. As its name indicates, it is situated at the summit of the divide, on the relocated railroad. It is the seat of a botanical experiment station.

Miraflores Lake and the Rio Cocoli appear as new localities in the present work. The lake is a small body of water situated on the Pacific side of the divide between Pedro Miguel and Miraflores Locks. It was formed by damming the now virtually destroyed Rio Grande. Its chief tributary is the Rio Cocoli. Sometimes, with the operation of Miraflores Locks, the lower flight of which is at sea level, the main body of this lake becomes slightly brackish, but not so much so as to exclude fresh-water fishes. This lake is connected with Culebra (or Gaillard) Cut and Gatun Lake through the Pedro Miguel Locks.

Alhajuela, an important collecting station during our earlier investigations, was at that time situated on the banks of the Chagres River, about a day's journey by cayuca upstream (eastward) from Gamboa, outside the Canal Zone. It served as a hydrographic station. It has now been abandoned, but the main building still stands, and is situated at the head of Gatun Lake, just below the recently constructed Madden Dam.

San Juan, formerly on the banks of the Rio Boquerón, a short distance above the union of this stream with the Chagres, is now situated on the newly formed Madden Lake, having been moved from its former location, which was flooded. Specimens listed in the present paper from the "mouth of the Boquerón" were taken some distance upstream from the former location of San Juan, where this river now empties into Madden Lake.

Most of the stretches of the upper Chagres and the Rio Indio, in which collections were made in 1911, now are included in or at least affected by Madden Lake.

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NEW SPECIES DESCRIBED

Gephyrocharax whaleri
Astyanax kompi
Bryconamericus zeteki
Brycon behreae
Brycon obscurus
Rivulus volcanus
Rivulus montium
Euleptoeleotris (gen. nov.) *clarki*
Euleptoeleotris shropshirei

CATALOGUE OF SPECIES

Family PIMELODIDAE. Naked Central and South American Catfishes

The genera appearing under Pimelodidae herein were placed under Siluridae in our earlier (1916) work. During recent years there has been a tendency to follow Regan (1911), who divided Siluridae into several families. The family Pimelodidae, as defined in part by Regan, is characterized by the separate gill membranes, which are free from the isthmus; 3 pairs of barbels (1 pair maxillary, 2 pairs mandibular, and no nasal barbels); anterior and posterior nostrils far apart; 6-rayed ventrals; and a well-developed adipose.

The key to the genera under the family Siluridae in our earlier publication may be followed, except that the second part relating to

the humeral process, under *c* and *cc*, should be transposed (see under *Pimelodus*).

Rhamdia Bleeker.

On the basis of records by Behre (1928) and myself (1928), and some additional specimens obtained recently, three species of this genus not included in our earlier work are added to the fauna of Panama. These three species are all Central American forms that have invaded western Panama.

The chief diagnostic characters of this genus are the weak, flexible dorsal spine; the short occipital process which does not reach the dorsal plate; the free orbital margin; and the rather long adipose fin which is adnate to the back.

The species are imperfectly understood. For this reason no key is offered, though characters that are supposedly diagnostic are mentioned in the accounts.

Rhamdia wagneri (Günther).

Pimelodus wagneri Günther, Trans. Zool. Soc. Lond., **1868**, p. 474—Atlantic and Pacific rivers of Panama.

Rhamdia wagneri Meek and Hildebrand, Field Mus. Nat. Hist., Zool. Ser., **10**, p. 240, 1916.

This common species was secured during the recent investigations in a stream flowing through Chillibrillo Cave, at Barro Colorado Island, and in a small creek flowing into an abandoned reservoir near Gatun. Since our earlier publication (1916) it has been recorded from several places in the Rio Chucunaque Basin by Breder (1927, p. 101), and from streams of both slopes of extreme western Panama by Behre (1928, p. 307).

The very long adipose fin, which begins in advance of the tips of the dorsal rays if deflexed, and which is much longer than the head; the very long maxillary barbel, which often reaches beyond the ventral; and the well-forked caudal aid in identifying this species.

Not much in evidence during the dry season, but when the wet season comes in April and May it schools. The writer has seen a dozen or more individuals swimming leisurely at the surface in quiet places among grass in the swollen streams, where they could be captured easily. It is evident that this fish does not find darkness objectionable, as it was common in a small stream in Chillibrillo Cave.

Attains a length of about 400 mm. (12 inches), and is said to be a food fish of good quality.

This species, as now understood, ranges from Costa Rica, southward into Colombia, possibly to Ecuador, and is common on both slopes of Panama, and in Colombia.

Rhamdia godmani (Günther).

Pimelodus godmani Günther, Cat. Fish. Brit. Mus., 5, p. 124, 1864—Vera Cruz, Mexico; Rio Motagua, Guatemala.

Included on the basis of a record by Behre (1928, p. 306) founded on specimens taken in the Rio Cricamola, on the Atlantic slope of extreme western Panama. *R. godmani* has not been reported from Costa Rica. Dr. Behre found her specimens to be somewhat intermediate in some respects between *wagneri* and *underwoodi*, and not entirely in conformity with *godmani*. I have not seen these specimens, but on the basis of distribution a new species is suggested, as *godmani* was recorded only from Vera Cruz, and Yucatan, Mexico; from the Rios Motagua and Usumacinta, Guatemala; and from Belize prior to Dr. Behre's record. Dr. Behre mentions a "Pacific coast" record from Honduras, and refers to *godmani* as "a north Pacific-coast form," but I have not been able to find a record of its occurrence on the Pacific slope. It seems somewhat significant that Meek (1914) did not record it from Costa Rica, and that the species was not recognized among the specimens from Costa Rica studied by me (1930).

This species seems to be characterized by the rather well-forked caudal fin; the short occipital process, which extends less than half the distance from its base to the origin of the dorsal; and the moderately long adipose, which is longer than in *rogersi*, but shorter than in *wagneri*, being about 1½ times the length of the head.

Rhamdia underwoodi Regan.

Rhamdia underwoodi Regan, Biol. Cent. Amer., Pisces, p. 135, pl. 23, fig. 4, 1907—Juan Viñas, Costa Rica.

Included in the fauna of Panama on the basis of specimens taken by Behre (1928, p. 308) in the Rio Cricamola, on the Atlantic slope of extreme western Panama. Recorded also from both slopes of Costa Rica.

This species is characterized by the rather deeply notched (not forked) caudal, the very short occipital process, which reaches only about one-fifth to one-sixth the distance from its base to the origin of the dorsal; the rather short adipose, which is not much longer than the head; and the short maxillary barbel, which reaches only about to the tips of the pectoral.

Rhamdia rogersi (Regan).

Pimelodus rogersi Regan, Ann. Mag. Nat. Hist., (7), **19**, p. 259, 1907—Irazú, Costa Rica.

Taken with hook and line in Miller's Spring, flowing into a tributary of the Rio Chiriquí Viejo, Pacific slope of extreme western Panama, from whence it was already recorded by Hildebrand (1928, p. 82).

Differs prominently from *R. wagneri* in the much shorter adipose fin, which begins far behind the tips of the dorsal rays, and is little if any longer than the head; in the much shorter maxillary barbel, which fails to reach the tips of the pectorals; and in the unforked caudal fin, which has only a slight notch.

It was originally described from Irazú, Costa Rica. It has been recorded from both slopes of Costa Rica; and from the Pacific slope of extreme western Panama, on the basis of specimens already mentioned.

Pimelodus Lacépède.

This genus differs prominently from *Pimelodella* in the much shorter and broader humeral process. Unfortunately, in the key to the genera in our earlier work (1916, p. 239) this well-marked difference between this genus and *Pimelodella* was transposed. When using that key, "humeral process broad, not spine-like," under *cc*, should be exchanged with "humeral process spine-like" under *c*. This difference is correctly stated in the descriptions of the genera. A single species is known from Panama.

Pimelodus clarias punctatus (Meek and Hildebrand).

Megalonema punctatum Meek and Hildebrand, Field Mus. Nat. Hist., Zool. Ser., **10**, p. 77, 1913—Rio Tuyra at Marrigante.

Pimelodus clarias punctatus Meek and Hildebrand, Field Mus. Nat. Hist., Zool. Ser., **10**, p. 241, 1916.

This subspecies is known only from the Tuyra Basin. Since the publication of our earlier work (1916), Breder (1927, p. 103) has recorded many specimens from the Rio Chucunaque, having found it nearly as common as *Rhamdia wagneri*.

Pimelodella Eigenmann and Eigenmann.

This genus is recognized by the stiff pungent dorsal spine; the deeply forked caudal; the long occipital process, which reaches the dorsal plate; the narrow spine-like humeral process, which reaches nearly opposite mid-length of the pectoral spine; and the free orbital

margin. In the key to the genera in our earlier work (1916) the differences in the humeral processes of this genus and *Pimelodus* were inadvertently transposed (see under the genus *Pimelodus*).

Pimelodella chagresi (Steindachner).

Pimelodus (*Pseudorhamdia*) *chagresi* Steindachner, Sitzber. Akad. Wiss. Wien, **74**, p. 584, 1876—Rio Chagres and tributaries.

Pimelodella chagresi Meek and Hildebrand, Field Mus. Nat. Hist., Zool. Ser., **10**, p. 242, 1916.

This common catfish was secured in Miraflores Lake and in the Rio Cocoli a short distance from the lake, and also in the Rio Cabra on the Panama City-Chepo Road. It is common on both slopes of central Panama and also in the Tuyra Basin of eastern Panama. Since our earlier work was published it was obtained by Breder (1927, p. 102) at several places in the Rio Chucunaque and tributaries, and through a record by Behre (1928, p. 308), based on specimens secured in the Rio Chiriquí del Tire, Pacific slope of western Panama, the range was extended considerably westward from the Canal Zone. The range as now understood extends from western Panama into Colombia, where it occurs in the Atrato and Magdalena basins. It is definitely known from both slopes only in central Panama.

This species should be handled with care, as it secretes the most painful poison of any catfish ever handled by the writer, who suffered severely for a half hour or so after being "finned," and who saw a native roll on the ground in agony after a like experience. Fortunately, no bad after effects were noticed.

This fish does not grow large enough to be of value as food, as it apparently seldom reaches a length as great as 150 mm. (6 inches).

Trachycorystes amblops (Meek and Hildebrand).

Felichthys amblops Meek and Hildebrand, Field Mus. Nat. Hist., Zool. Ser., **10**, p. 77, 1913—Rio Tuyra at Marrigante.

Trachycorystes amblops Meek and Hildebrand, Field Mus. Nat. Hist., Zool. Ser., **10**, p. 243, 1916.

Three small specimens, respectively 43, 54, and 63 mm. long, were taken in a swamp at the La Jagua Hunting Club, situated on the Pacific slope, about 15 miles east of Panama City. This species was known heretofore only from the lower part of the Rio Tuyra Basin from specimens reported in our earlier work (1916, p. 243) and by Breder (1927, p. 104).

The specimens at hand agree well with the Rio Tuyra material. The sides are marked with dark longitudinally elongate spots, which are almost united along middle of side in the 54 mm. specimen, form-

ing a lateral band. The description in our earlier work stated that the dorsal spine had "barbels" on the anterior margin. "*Barbs*" obviously should be substituted for "barbels."

The following proportions and counts are based on the three small specimens at hand: Head 3.4 to 3.9; depth 3.6 to 3.7; D. I, 5 or 6; A. 18 to 20. Snout 4 to 4.4 in head; eye 5.6 to 6.3; interorbital 1.4 to 1.8; caudal peduncle 2.5 to 2.8. Pectoral spine 3.9 to 4.7 in standard length.

Ageneiosus Lacépède.

Maxillary barbels only are present in this genus; the orbital margin is not free; the occipital process is joined to the dorsal plate, and the humeral process is wanting. The single species of this genus known from Panama has been taken there only in the Tuyra Basin.

Ageneiosus caucanus Steindachner.

Ageneiosus caucanus Steindachner, Denkschr. Akad. Wiss. Wien, **41**, p. 61, pl. 6, figs. 1, 2, 1880—Rio Cauca; Meek and Hildebrand, Field Mus. Nat. Hist., Zool. Ser., **10**, p. 245, 1916.

This fish, known in Panama only from the Tuyra Basin, has been reported, since the publication of our earlier work, by Breder (1927, p. 104) from the Rio Chucunaque at the island below Yavisa. According to Eigenmann (1922, p. 50) this species occurs also in the Atrato and Magdalena basins.

Family LORICARIIDAE. Mailed Catfishes

This family of South American Nematognathi ranges northward into eastern and central Panama, the northernmost record for Panama being "Veragua," presumably meaning the State of Veraguas (see under *Plecostomus plecostomus panamensis*). No representatives of the family have been found in extreme western Panama, that is, in the states of Chiriquí and Bocas del Toro, where Dr. Ellinor H. Behre and others have collected. However, there is a record in the National Museum of a *Plecostomus plecostomus* taken in the Quebrada de India, Colorado de Coto, Costa Rica. The species are widely distributed in South America. Charles M. Breder, Jr. (1925 and 1927) working in the Chucunaque Basin of eastern Panama, added many records from that river system, and described a new species.

We are indebted to Mr. Breder also for information in regard to the food of these fishes. In general the intestinal tract is long and convoluted, as typical of herbivorous fishes. It is much longer, however, in members of the subfamily Plecostominae, including the genera *Plecostomus, Chaetostomus, Ancistrus, Lasiancistrus,* and

Leptoancistrus, than in the members of the subfamily Loricariinae, which includes among the Panama fauna the genera *Loricaria* and *Sturisoma*. The food in all the species consisted of a flocculent material, composed largely of algae and mud, which is probably obtained, by scraping and sucking, from the rocks and pebbles among which the species commonly live.

Plecostomus plecostomus panamensis Eigenmann.

Plecostomus plecostomus panamensis Eigenmann, Mem. Carnegie Mus., 9, No. 1, p. 69, 1922—Chagres River at Monte Lirio and Gatun.

This fish, like *Ancistrus chagresi*, commonly lives in streams among the rocks. It seemed to be more numerous than the relative just mentioned during our work in 1911 and 1912. Only one specimen, 345 mm. long, was taken during the recent investigation. This one was secured in Miraflores Lake at the mouth of the Rio Cocoli. This capture does not show, however, that the species is living under lake conditions. It evidently was not taken oftener in 1935 and 1937 because little collecting was done in rocky streams, its usual habitat.

The very long convoluted intestine is generally filled with a slimy mass, apparently mostly of vegetable origin. Breder (1927, p. 108) stated that the intestines were "all packed with soft flocculent mud, algae, *et cetera*." It clings closely to stones. In 1912, while collecting in the upper Tuyra Basin, the fish could be seen clinging to stones, and we succeeded in capturing a few specimens by lifting stones with fish attached, from the water. The fish clung to the stones so tightly with their sucking mouth and flat chest and abdomen, that it took some little power to remove them.

This species is listed as *P. plecostomus* in our earlier work (1916, p. 247). However, Eigenmann (1922, p. 69) found the Panama specimens to differ from typical *P. plecostomus* of South America in having the occipital plate bordered by several (3 or more) small plates instead of 1 or 2 larger ones. Accordingly, Eigenmann recognized the Panama specimens as representatives of a new subspecies, for which he offered the name *panamensis*.

To the synonymy in our earlier work should be added *Plecostomus bicirrhosus* Günther (1866, p. 477), reported from "Pacific and Atlantic coast rivers of Panama," and *Plecostomus guacari* Regan (1907, p. 111).

Although Eigenmann (1922, p. 75) recognized *Chaetostomus aspidolepis* Günther (1866, p. 603; and 1868, p. 477), reported from "Veragua" (presumably meaning the State of Veraguas of western

Panama) as distinct, placing it in the genus *Hemiancistrus*, I shall regard it as synonymous with *P. plecostomus panamensis* for the reasons stated: Only Günther's description is available to us, which was based on a skin (presumably dry, though not so stated) 12¼ inches long. Owing to the removal of the soft parts, and drying, it probably was somewhat distorted. The apparently larger interopercular spines, which evidently led Eigenmann to place it in the genus *Hemiancistrus* (a genus otherwise not found in Panama), may well have seemed longer because of shrinkage. The other difference that apparently might be of some importance is the supposedly narrower head. This apparent difference also might have resulted from shrinkage. The proportionate length of the head, however, agrees with Canal Zone specimens. It probably is significant, also, that the number of fin rays and scutes given agrees with specimens that are undoubtedly *P. plecostomus panamensis*.

No Loricariidae were taken in the extreme western states of Panama, namely, Chiriquí and Bocas del Toro, by Dr. Ellinor H. Behre, and others who collected there. Günther's record, "Veragua," therefore, remains as the westernmost one of the family in Panama. However, there is a record of a specimen in the United States National Museum, identified by Dr. George S. Myers, from the Quebrada de India, a Pacific slope stream, a tributary of the Rio Colorado, which is a tributary of the Rio Coto. Upon inquiry from Professor Manuel Valerio, the collector, I am informed that this spcies is known locally as "Arrisuaca," and that it is common enough to be used as food.

Though *P. plecostomus* ranges south to Uruguay, the subspecies *panamensis*, as now understood, is found in Panama, from Veraguas(?) to the Rio Tuyra Basin in Darien. In central Panama it occurs on both slopes. It is not reported from the Bayano, though it very probably occurs there. The single specimen from Costa Rica, mentioned in the preceding paragraph, very probably belongs to this subspecies.

Chaetostomus fischeri Steindachner.

Chaetostomus fischeri Steindachner, Denkschr. Akad. Wiss. Wien, **41**, p. 162, pl. 4, 1879—Rio Mamoni, near Chepo; Meek and Hildebrand, Field Mus. Nat. Hist., Zool. Ser., **10**, p. 249, 1916.

This species was not taken during the recent investigation probably because virtually no collecting was done in suitable places in streams. Since our earlier work (1916, p. 249) was published, Breder

(1927, p. 109) has reported it from the Chucunaque Basin from the "Rio Chico and Sucubtí in clear water."

This species is recorded from both slopes of central Panama and from the Pacific slope of eastern Panama. Presumably it is rare in the Chagres Basin, as we took only one specimen there during our intensive collecting in 1911 and 1912. According to Eigenmann (1922, p. 82) this species occurs on both slopes of Colombia and southward into Ecuador.

Ancistrus chagresi Eigenmann and Eigenmann.

Ancistrus chagresi Eigenmann and Eigenmann, Proc. Calif. Acad. Sci., (2), **2**, p. 47, 1889—Rio Chagres; Meek and Hildebrand, Field Mus. Nat. Hist., Zool. Ser., **10**, p. 251, 1916.

Eight specimens, ranging in length from 37 to 235 mm., were seined along Madden Dam Road, in a creek formerly a tributary of the Rio Chagres and now flowing into Gatun Lake. As no specimens were secured in Gatun or Miraflores Lake, it is not known whether this typical river fish is living in these artificial lakes, though it was present in some parts of the Chagres River, now included in Gatun Lake, before the canal was completed. This species commonly lives in streams on rocky bottom, clinging closely to rocks with its sucking mouth and flat chest and abdomen.

Policeman S. A. Venable of the Canal Zone, who is interested in "pet fish," kept small individuals of this species in his aquaria, when observed in 1935, to act as scavangers. This fish is sluggish in the aquarium, and as in nature it stays chiefly on the bottom.

A specimen, 75 mm. long, when observed in Mr. Venable's aquarium, was dark green with pale round spots on the upper surface of the head and body.

This species is known only from central Panama where it has been taken on both slopes.

Ancistrus spinosus Meek and Hildebrand.

Ancistrus spinosus Meek and Hildebrand, Field Mus. Nat. Hist., Zool. Ser., **10**, p. 252, 1916—Rio Calobre, tributary to Rio Bayano.

This species was not taken during the recent investigation. It was described by us (1916, p. 252) from only two specimens, one from the Bayano and the other from the Tuyra Basin. Since that time Breder (1927, p. 109) has reported it from five specimens taken in the Chucunaque Basin from the "Rio Chico, the Sucubtí and the latter's confluent in clear water in company with *Chaetostomus*."

Lasiancistrus planiceps (Meek and Hildebrand).

Ancistrus planiceps Meek and Hildebrand, Field Mus. Nat. Hist., Zool. Ser., **10**, p. 79, 1913—Rio Tuyra, Boca de Cupe; Field Mus. Nat. Hist., Zool. Ser., **10**, p. 253, pl. 10, 1916.

This species, described from specimens from the Rio Tuyra and its upper tributaries, has been recorded also from eight specimens by Breder (1927, p. 108) from the "Rio Chucunaque, above the mouth of the Rio Chico, at the Indian village; Rio Sucubtí, at the Indian village and the creek near it, below the falls."

Leptoancistrus canensis (Meek and Hildebrand).

Acanthicus canensis Meek and Hildebrand, Field Mus. Nat. Hist., Zool. Ser., **10**, p. 80, 1913—Rio Cana, Cana, Panama.

Leptoancistrus canensis Meek and Hildebrand, Field Mus. Nat. Hist., Zool. Ser., **10**, p. 254, pl. 11, 1916.

Known only from the type material collected in small mountain streams near Cana in the upper Tuyra Basin.

Loricaria uracantha Kner and Steindachner.

Loricaria uracantha Kner and Steindachner, Abhand. Bayer. Akad. Wiss. München, **10**, p. 56, pl. 6, 1866—New Granada; Rio Chagres; Meek and Hildebrand, Field Mus. Nat. Hist., Zool. Ser., **10**, p. 256, 1916.

A single small specimen, 55 mm. long, was seined along the Madden Dam Road, in a creek formerly a tributary to the Rio Chagres and now flowing into Gatun Lake.

We found this species very common in streams in shallow water with swift current and a sandy or gravelly bottom in the Chagres Basin in 1911 and 1912. It evidently was not secured oftener during my recent work because very little collecting was done in suitable places.

The species has been recorded from "Atlantic and Pacific rivers of Panama," but we have taken it only in the Chagres Basin, and are inclined to doubt the Pacific slope record.

Loricaria latiura Eigenmann and Vance.

Loricaria filamentosa latiura Eigenmann and Vance, in Eigenmann, Indiana Univ. Studies, No. 16, p. 13, 1912—Boca de Certegai, Colombia; Meek and Hildebrand, Field Mus. Nat. Hist., Zool. Ser., **10**, p. 257, 1916.

This species appears under the trinomial, *L. filamentosa latiura*, in our earlier work. However, Eigenmann (1922, p. 91) considered *latiura* sufficiently different from *filamentosa* to give it full specific rank.

As understood by Eigenmann, *L. latiura* occurs in the Tuyra and Atrato basins. This is one of several species that are common

to the Tuyra on the Pacific slope of Panama and the Atrato on the Atlantic slope of Colombia.

Loricaria variegata Steindachner.

Loricaria variegata Steindachner, Denkschr. Akad. Wiss. Wien, **41**, p. 163, pl. 3, 1879—Rio Mamoni, near Chepo; Meek and Hildebrand, Field Mus. Nat. Hist., Zool. Ser., **10**, p. 258, 1916.

Nine specimens, ranging in length from 16 to 210 mm., were reported from the Chucunaque Basin by Breder (1927, p. 112). Previously the species had been recorded in Panama from the "Rio Mamoni, near Chepo" (type locality) and from the Rio Tuyra. Mr. Breder states: "The present series varies beyond the limits of the Meek and Hildebrand, 1916, description as follows: The cross-row of scutes between the pectorals is obsolescent in some specimens, being merely represented by a few scattered asperities on the otherwise smooth skin. In some cases the plates anterior to the vent are scarcely enlarged and the caudal varies from strongly emarginate to forked. The longest caudal filament (99 mm.) is on a male of 199 mm., as measured from the tip of the second, not produced, caudal ray."

According to Eigenmann (1922, p. 93), it occurs in the Atlantic drainage of Colombia in the Atrato and Magdalena basins. The extremes of the range, then, are the Rio Mamoni on the Pacific slope of Panama and the Rio Magdalena on the Atlantic slope of Colombia. It is not reported from the Pacific slope of Colombia.

Loricaria capetensis Meek and Hildebrand.

Loricaria capetensis Meek and Hildebrand, Field Mus. Nat. Hist., Zool. Ser., **10**, p. 80, 1913—Rio Capetí, tributary to the Tuyra; p. 259, pl. 12, 1916.

Known only from the two original specimens from the Tuyra Basin. Breder (1927, p. 111) has questioned its validity (see under *L. fimbriata*).

Loricaria fimbriata Eigenmann and Vance.

Loricaria fimbriata, Eigenmann and Vance, Indiana Univ. Studies, No. 16, p. 12, 1912—Boca de Certegai and Bernal Creek, Colombia; Meek and Hildebrand, Field Mus. Nat. Hist., Zool. Ser., **10**, p. 260, 1916.

Previously known from Panama only from 4 specimens, 50 to 80 mm. long, taken in the Rio Capetí (tributary of the Tuyra), by Meek and Hildebrand (1916, p. 260), and reported by Breder (1927, p. 111) from a specimen 54 mm. long, from the Rio Tupisa, tributary of the Chucunaque. Breder has suggested that three closely related species, namely, *fimbriata* and *capetensis* from the Tuyra Basin, and *seminuda* from Girardot on the Magdelena River in

Colombia, should be reduced to one. These nominal species are supposedly distinguished chiefly by the differences in the development of the abdominal scutes. Since the degree of development of the scutes almost certainly depends largely upon age and size of the fish, Mr. Breder is probably correct. However, not enough specimens are available (none of *seminuda*) to determine definitely that no differences exist in fully mature specimens, wherein differences could not be ascribed to age.

Loricaria altipinnis Breder.

Loricaria altipinnis Breder, Amer. Mus. Nat. Hist., Nov., No. 180, p. 1, fig. 2, A and B, 1925—Rio Chico, Darien, Panama; Bull. Amer. Mus. Nat. Hist., 57, p. 110, fig. 4, 1927.

According to Breder (1925, p. 3), this fish may be distinguished from *L. uracantha*, the most closely related species in Panama, "by the anterior rays of the dorsal reaching beyond those of the posterior ones when depressed, instead of being co-terminous; the distance from the origin of dorsal to longest deflexed ray being equal to the distance from the tip of snout to posterior margin of occipital plate instead of to the middle of that plate; the distance from origin of anal to longest deflexed ray being equal to the distance from the snout to a point well past the orbital notch instead of to its posterior margin. The smaller examples differ greatly from young *L. uracantha* of the same size, as those closely resemble the larger examples of that form, instead of differing from them, as previously noted for the present species."

Mr. Breder gave the following counts and proportions, based on the type and on 11 paratypes, ranging in length from 38 to 163 mm: Head 4.2 to 4.6; depth 10 to 12.5; lateral scutes 28 or 29. Snout 2.1 to 2.4 in head; eye 5 to 8; interorbital 4 to 5.1; pectoral 1.3 to 1.4. Abdominal plates 3 to 7. The color is described in the type (standard length 154 mm.) as "brownish above, lighter below, the back crossed by six darker bars, the first on nape, indistinct, the second at base of dorsal, the rest approximately equidistant on the remainder of the body. All fins yellowish with dark spots, anal with fewer and lighter ones."

The smaller paratypes, ranging in length from 38 to 94 mm., are described as similar in color, but darker, tending to be "Vandyke brown" instead of tan.

This species is known only from the type material of which Breder said (1927, p. 110): "Known only from the Rio Chucunaque and its

confluents.... Most frequently taken in pools in the dry beds of evaporating side streams."

Sturisoma Swainson.

Sturisoma Swainson, Nat. Hist. Fish., Amph. Rept., 2, p. 304, 1839—type *Loricaria rostrata* Spix.

The above name has replaced *Oxyloricaria* Bleeker (1863) used in our earlier work (1916, p. 261), on the basis of priority.

Sturisoma panamensis (Eigenmann and Eigenmann).

Loricaria panamensis Eigenmann and Eigenmann, Proc. Calif. Acad. Sci., (2), **2**, p. 34, 1889—Panama.

Oxyloricaria panamensis Meek and Hildebrand, Field Mus. Nat. Hist., Zool. Ser., **10**, p. 261, 1916.

Breder (1927, p. 113) recorded 22 specimens from the Chucunaque Basin. Meek and Hildebrand (1916, p. 261) had reported the species common in the Rio Tuyra, but rare in the Bayano (type locality).

The general range as given by Eigenmann (1922, p. 94) extends from the Bayano and Tuyra basins (Pacific slope) in Panama, through both slopes of Colombia to western Eucador.

Sturisoma citurensis (Meek and Hildebrand).

Oxyloricaria citurensis Meek and Hildebrand, Field Mus. Nat. Hist., Zool. Ser., **10**, p. 82, 1913—Rio Cupe, Cituro; p. 262, pl. 13, 1916.

Breder (1927, p. 113) recorded seven examples from the Chucunaque Basin. We (1916, p. 262) reported it abundant in the Rio Tuyra, but rare in the Bayano. Its distribution, so far as known, is limited to the basins of the Bayano and Tuyra of the Pacific slope of Panama.

Family CALLICHTHYIDAE

Hoplosternum punctatum Meek and Hildebrand.

Hoplosternum punctatum Meek and Hildebrand, Field Mus. Nat. Hist., Zool. Ser., **10**, p. 264, pls. 14 and 15, 1916—Rio Marte Arnade, near Panama City.

Described in our earlier work from four specimens taken in the Rio Marte Arnade, about six miles east of Panama City. Since that time Breder (1927, p. 107) has reported 183 specimens, 30 to 66 mm. long, from the Rio Chucunaque, near Yavisa, where the species seems to be common, though not seen by us in the Rio Tuyra. There is now at hand one additional specimen, 60 mm. long, seined in a swamp at the La Jagua Hunting Club, about 15 miles east of Panama City. This specimen conforms well with the type material from the Rio Marte Arnade, except that the origin of the dorsal seems rather farther back, being equidistant from tip of snout and

the beginning of adipose, wherein it conforms more nearly with Breder's specimens from the Tuyra drainage.

It is known only from the specimens mentioned in the foregoing paragraph, taken in a Pacific coastal stream and swamp not far from Panama City and in the Tuyra Basin. A closely related species, *H. magdalenae,* occurs in the Atlantic drainage in Colombia.

Family ASTROBLEPIDAE

The above name is substituted for Cyclopidae in our earlier work (1916, p. 265) for reasons stated in the account of the genus *Astroblepus.* A single genus with one species is known from Panama.

Astroblepus Humboldt.

Astroblepus Humboldt (in Humboldt and Bonpland), Recueil d'observations de zoologie et d'anatomie comparée faites dans l'Océan Atlantique, dans l'intérieur du nouveau continent et dans la Mer du Sud, pendant les années 1799, 1800, 1801, 1802, et 1803, **13**, 48 pages, 7 pls.; Pt. 4, 1805, Mémoire sur l'Eremophilus et l'Astroblepus deux nouveaux genres de l'ordre des Apodes, par M. de Humboldt, p. 37 (type *Astroblepus grixalvii*).[1] The accounts of *Astroblepus* and *A. grixalvii* appear also in the Philosophical Magazine (London), without reference to the earlier work, **24**, February to May, 1806, Art. 59, pp. 329 to 333, Memoir on the Eremophilus and Astroblepus, two new Genera of the Order Apodes. By M. de Humboldt. The account of *Astroblepus* is given on page 331 and a drawing of *A. grixalvii* appears on pl. 7, which has the same number as the one in the earlier work published in Paris.

The name given above, following Eigenmann (1922, p. 51), replaces *Cyclopium* in our earlier work (1916, p. 265). Eigenmann stated: "The mountain cat-fishes, hitherto known chiefly under the names *Cyclopium* and *Arges,* are considered here under the above generic name. *Astroblepus* was described by Humboldt as lacking ventrals, and has not been recognized since the publication of the original description, based on 'pescado negro' of Popayán.

"Posada, a Colombian naturalist (cf. his Estudios Cientificos, 1909), made a special effort to secure such a fish lacking ventrals, but did not find any, although many specimens were examined.

[1] The book cited above is volume 13 of a general work consisting of 24 volumes published in Paris from 1805 to 1837, entitled, Voyage aux regions equinoxiales du nouveau continent, fait au 1799–1804, etc., par Frederich Heinrich Humboldt et A. J. A. Bonpland. A second edition of the volume on Zoology, etc. (13), was published in Paris in 1811, wherein an account of *Astroblepus* appears in volume 1, page 19.

"Likewise in our collections, numbering hundreds of individuals, no specimens lacking ventrals are to be found. It seems, therefore, that the lack of ventrals in the figure of Humboldt is due to a mistake of the artist. Humboldt's name must stand as the earliest designation of these fishes."

The acceptance of this earlier name necessitates also the change of the family name from Cyclopidae to Astroblepidae.

Astroblepus longifilis (Steindachner).

Arges longifilis Steindachner, Denkschr. Akad. Wiss. Wien, **46**, p. 19, pl. 5, fig. 3, 1882—Rio Huambo, Rio Totora, northern Peru.

Eigenmann (1922, p. 54) synonymized *Cyclopium pirrense* Meek and Hildebrand (1916, p. 265) with the above. Breder (1927, p. 105) reported seven specimens from the "Rio Sucubtí, in the creek at the Indian village, above the falls," Chucunaque Basin. In Panama this species has been reported only from the Rio Tuyra drainage. According to Eigenmann (1922, p. 54) this species ranges from the Rio Tuyra in eastern Panama to Peru, occurring in some places on both slopes.

Family PYGIDIIDAE

Prior to the work of Behre (1928) a single species of this family was known from Panama, which was reported only from the Rio Tuyra drainage.

Pygidium septentrionale Behre.

Pygidium septentrionale Behre, Ann. Carnegie Mus., **18**, p. 309, pl. 18, 1928—Quebrada Solão, tributary to the Rio Chiriquí del Tire, near Caldera, western Panama.

No specimens have been seen by me. I quote from the original description.

"Head as broad as long; distance from chin to nearest point of gill, half the width of head. Length of head 6 to nearly 7 in length to base of caudal. Diameter of eye 3 in interocular width. Maxillary barbels reaching to origin of pectorals or shorter. Teeth conical, sharply pointed. Dorsal, caudal, and anal fins truncate. Pectoral filament short. Origin of dorsal above or a little in advance of vent and equidistant from tip of caudal and preopercle; distance from caudal nearly 2 in its distance from snout. Last dorsal ray over anal, but not over last. Origin of ventrals nearer tip of pectoral filament than caudal. Color slate inclining to brownish, mottled, especially below. Belly also dark."

This species is known from 12 specimens, ranging in length from 69 to 110 mm., secured by Dr. Behre in the Rio Chiriquí del Tire, in the vicinity of Caldera, at an altitude of about 4,000 feet.

Apparently the head is shorter and broader than that of *striatum*, being at least as broad as long, and its length is contained 6 to nearly 7 times in the standard length. The origin of the anal is farther forward with respect to the dorsal, as its origin is in advance of the last ray of the dorsal, whereas in *striatum* the origin of this fin is under or behind the last ray of the dorsal. *P. septentrionale* seems to be plainer in color, being slate to brownish and mottled, especially below. *P. striatum* is light olive and has a dark lateral band, and sometimes one additional one above and below the one along the middle of the side. These bands are sometimes more or less broken up into spots. The larger individuals have black spots on the back and sometimes on the lower parts also.

Pygidium striatum Meek and Hildebrand.

Pygidium striatum Meek and Hildebrand, Field Mus. Nat. Hist., Zool. Ser., **10**, p. 78, 1913; p. 266, 1916—Rio Cana, Cana, Panama.

This was the only species of the genus and family known from Panama, until Behre (1928, p. 309) described *P. septentrionale* from western Panama, where she also took one specimen of *P. striatum*. Previously, the last-mentioned species was known only from the type material from a small mountain stream at Cana in the upper part of the Rio Tuyra Basin. Dr. Behre took the fish at an elevation of about 4,000 feet.

According to Eigenmann (1922, p. 64) this species occurs also on both slopes of the mountains of Colombia. Although the species has not been taken in central Panama, where the elevation probably is too low, the general range apparently extends from western Panama into Colombia.

Family CHARACINIDAE

The members of this family are very numerous, ranging from the Rio Grande in Texas to Argentina and Peru. They are most abundant, however, in the equatorial parts of South America and become comparatively few north of the Isthmus of Panama. Some of the species grow large and are of value as food fishes, but many of them are small. The shape of the body varies from short and deep and strongly compressed, to long and slender or even pike-like. Scales are present on the body, but not on the head; the upper jaw anteriorly is formed by the premaxillaries, and laterally by the maxillaries; teeth

various, often strong, and rarely wanting (as in *Curimatus*); dorsal fin small, without spines; an adipose fin is usually present (wanting in *Hoplias*).

In Panama the species have various names, as shown subsequently. In general the large species (*Brycon*) are called "sábalo," that is, herring, and the small species are mostly called "sardina," that is, sardines.

One genus, *Characidium*, has been added to the fauna of Panama since the publication of our earlier (1916) general work. A description is offered subsequently.

Characins are decidedly fewer in western than in central and eastern Panama. Dr. Behre (1928) secured only five genera, namely, *Brycon, Astyanax, Bryconamericus, Hyphessobrycon,* and *Roeboides* (including nine species), in western Panama, whereas these and 14 others (including 32 species) are known from the central and eastern sections of the republic. It seems evident, then, that many of the genera have their northernmost limit of distribution in central and eastern Panama. In fact, four genera, namely, *Apareiodon, Phanagoniates, Hemibrycon,* and *Characidium,* have been found no farther north (west) than the Tuyra Basin.

Curimatus Oken.

The members of this genus are widely distributed, ranging from Panama to Argentina and Peru. One species is known from Panama. The genus is characterized by the elongate robust body; the small mouth, which is without lips and without teeth; the complete lateral line; well-developed adipose fin; and the very long intestine.

Curimatus magdalenae Steindachner.

Curimatus magdalenae Steindachner, Denkschr. Akad. Wiss. Wien, **29**, p. 50, 1878—Rio Magdalena; Meek and Hildebrand, Field Mus. Nat. Hist., Zool. Ser., **10**, p. 269, 1916.

Specimens were secured in 1935 and 1937 on the Pacific slope east of Panama City at the La Jagua Hunting Club, in the Rio Tapia, and in the Rio Cabra.

Breder (1927, p. 113) recorded specimens from several places in the Chucunaque Basin.

Known from the Pacific slope of Panama, from the Rio Chorrera to the Rio Tuyra; also from the Atlantic slope of Colombia (Atrato and Magdalena basins) and southward into Venezuela. Although it has been taken by us on both sides of the Canal Zone, we have not found it within the Zone. This fish is herbivorous, as suggested by

the very long intestine. It usually lives in quiet shallow water, which at times is very warm.

Apareiodon dariensis (Meek and Hildebrand).

Parodon dariensis Meek and Hildebrand, Field Mus. Nat. Hist., Zool. Ser., **10**, p. 83, 1913—Rio Cupe, tributary of the Tuyra.

Apareiodon dariensis Meek and Hildebrand, Field Mus. Nat. Hist., Zool. Ser., **10**, p. 271, pl. 17, 1916.

Originally described from three specimens taken in the Rio Cupe, tributary to the Rio Tuyra. Breder (1927, p. 114) recorded a fourth specimen from the Rio Chucunaque from slightly above the mouth of the Rio Chiatí. He, also, secured a second species of the genus, a description of which appears herewith.

A. dariensis remains known only from the Tuyra Basin.

Apareiodon compressus Breder.

Apareiodon compressus Breder, Amer. Mus. Nat. Hist., Nov., No. 180, p. 4, figs. 3, 4, 1925; Bull. Amer. Mus. Nat. Hist., **57**, p. 115, figs. 5, 6, 1927—Rio Tuquesa, Chucunaque Basin, Darien, Panama.

This species is known from a single specimen, 23 mm. long, which has not been seen by me. The following description is condensed after Breder.

Head 3.2, depth 3.9, D. 11, A. 9, scales 36. Body elongate, somewhat compressed; dorsal profile convex; snout bluntly pointed, not much in advance of mouth, 4.4 in head; eye 3; interorbital 3.1; mouth very small, inferior; lower jaw toothless; upper jaw with large, close-set overlapping teeth, wide at tips, with slightly rounded pectinate margins; lateral line straight; dorsal fin inserted in advance of ventrals, its origin about midway between snout and base of caudal; anal fin small, shorter than head, its origin nearer to base of caudal than to base of ventrals; ventral fins broad, with 9 rays, reaching beyond vent; pectorals broad, with 14 rays, not reaching ventrals.

Color only slightly darker above than below; sides with a dark band, following lateral line; base of caudal with an elongate black spot; nape with a dark triangular area, connected with a median dark line extending to dorsal fin. Dorsal and caudal slightly dusky; other fins plain.

This species differs prominently from the only other one (*dariensis*) of the genus known from Panama, in the much shorter and less strongly projecting snout, and in color. In *dariensis* the snout is pointed, much in advance of the mouth, and is contained in the head 2.8 to 3 times. The color is dark brown above, the sides have

2 more or less broken black bands, and the dorsal and caudal lobes are prominently barred with black.

Characidium Reinhardt.

Small or minute fishes, elongate and generally subcylindrical in form. The jaws are provided with a single series of conical or tricuspid teeth; no frontal fontanel, but a small circular occipital one; lateral line complete; gill membranes free from the isthmus; adipose fin present.

Known from Panama from a single species, described by Breder (1925, p. 5). Therefore, it is not included in the general work on the fresh-water fishes of Panama by Meek and Hildebrand (1916). The species of the genus are described by Eigenmann (1922, p. 121) as living like and resembling *Etheostoma* (the darters) of North America.

Characidium marshi Breder.

Characidium marshi Breder, Amer. Mus. Nat. Hist., Nov., No. 180, p. 5, fig. 5, 1925; Bull. Amer. Mus. Nat. Hist., 57, p. 115, 1927—Rio Sucubtí, Chucunaque Basin, Darien, Panama.

This species is known only from the type material, consisting of eleven specimens ranging in length from 15 to 44 mm. The specimens have not been seen by me. The following description is condensed after Breder.

Head 3.3 to 3.8; depth 3.9 to 4.7; D. 11; A. 7 to 9; scales 31 to 35, in front of dorsal 10 or 11, across peduncle 5 to 7. Body elongate, subcylindrical; dorsal profile convex; snout bluntly pointed, 4 to 4.3 in head; eye 3.9 to 4.7; mouth subterminal; maxillary reaching eye; teeth conical in upper jaw, weakly tricuspid in lower jaw; lateral line weakly developed, complete, slightly decurved; dorsal fin inserted in advance of ventrals, about equidistant from anterior margin of eye and tip of adipose; adipose over last anal rays; pectorals reaching ventrals, the outer rays thickened, the fins equal to length of head.

Color dark above, paler below; side with a dark band crossed by 7 vertically elongate spots, the last one extending somewhat on middle caudal rays, encompassing a small black dot. Dorsal dusky, crossed by a dark bar on basal half; other fins plain dusky.

This is the only species of the genus known from Panama.

Phanagoniates macrolepis (Meek and Hildebrand).

Roeboides macrolepis Meek and Hildebrand, Field Mus. Nat. Hist., Zool. Ser., **10**, p. 84, 1913—Rio Cupe, Tuyra Basin.

Phanagoniates macrolepis Meek and Hildebrand, Field Mus. Nat. Hist., Zool. Ser., **10**, p. 272, 1916.

Since the publication of our earlier (1916) work, Breder has recorded this fish from the Rio Chico and the Rio Sucubtí in the Chucunaque Basin.

This species is known from the Tuyra Basin in Panama and the Atrato in Colombia. In the Tuyra it seems to be rather rare.

Compsura Eigenmann.

The minute fishes of this genus (the Panama representative apparently being less than 50 mm. in length) differ from related forms in the peculiarly enlarged scales on the base of the lower lobe of the caudal fin in the male. The genus is further characterized by having a single series of multicuspid teeth in each jaw, and by having an incomplete lateral line, present on only about 5 to 13 scales. A conspicuous black caudal spot is present in the single species occurring in Panama waters.

Compsura gorgonae (Evermann and Goldsborough).

Cheirodon gorgonae Evermann and Goldsborough, Proc. Biol. Soc. Wash., 22, p. 99, figs. 1, 3, 1909—Gorgona, Canal Zone.

Compsura gorgonae Meek and Hildebrand, Field Mus. Nat. Hist., Zool. Ser., 10, p. 274, 1916.

This is the smallest of the characins ("sardinas") occurring in the local waters. No individuals exceeding a length of 40 mm. have been found. Although it occurs on both slopes of central Panama, it does not seem to be numerous there. Specimens were secured in 1935 and 1937 in an abandoned reservoir at Mount Hope; in Gatun Lake at Gatun and Barro Colorado Island; in Madden Lake; in a creek tributary to Gatun Lake on Madden Dam Road; in the Rio Cocoli, tributary to Miraflores Lake; in the Rio Cabra; and in a swamp at the La Jagua Hunting Club. The three localities last named are on the Pacific slope. As this species occurs naturally on both slopes of Panama, it is not possible to determine from the specimens collected whether it uses the Pedro Miguel Locks as a passageway between Gatun Lake (Culebra Cut) and Miraflores Lake.

The rather short deep compressed body, the incomplete lateral line (present on only about 5 to 13 scales) and the large black spot on the base of the caudal fin are recognition marks. The single series of multicuspid teeth in each jaw, and peculiarly enlarged scales on the base of the lower lobe of the caudal fin are other distinguishing characters. The following proportions and counts are based on seven specimens unless otherwise stated:

Head 3.75 to 4.3; depth 2.6 to 3; D. 10; A. 17 to 20; P. 10 to 12; scales 4 or 5—30 to 34—3 or 4; vertebrae 12 or 13+17 or 18 (two specimens examined). Snout 4.8 to 6 in head; eye 2.7 to 3.2; interorbital 3.2 to 4. Distance from snout to dorsal 1.8 to 2 in standard length; base of anal 4 to 4.9; pectoral 4.6 to 5.

This fish was recorded from the upper Rio Chucunaque by Breder (1927, p. 117). Its range, so far as known to date, is limited to both slopes of central Panama, and the Tuyra Basin in eastern Panama.

Pseudocheirodon Meek and Hildebrand.

This genus, of which a single species is known, is characterized by the compressed body with elevated back; the broad second suborbital which covers nearly the entire cheek; the single series of premaxillary and mandibular teeth with expanded tips that overlap more or less; the incomplete lateral line, usually present on only 8 to 12 scales; and the normally scaled base of caudal and non-protruding interhaemal spines in both sexes.

Pseudocheirodon affinis Meek and Hildebrand.

Pseudocheirodon affinis Meek and Hildebrand, Field Mus. Nat. Hist., Zool. Ser., **10**, p. 275, pl. 18, 1916.

In 1935 and 1937 specimens were collected in an abandoned reservoir at Mount Hope; in the upper end of Gatun Lake (Chagres River), not far from Madden Dam; in Miraflores Lake, in swamps at the La Jagua Hunting Club; and in several small coastal streams on the Pacific slope, including the Pacorá, the Cabra, and a small stream near Campaña. As this species was common to both slopes before the Canal was opened, it cannot be determined from the collections whether it uses the Pedro Miguel Locks as a passageway.

P. affinis seldom exceeds a length of 55 mm. It is most readily recognized by the single series of teeth on the premaxillaries; the incomplete lateral line, which is usually present on only 8 to 12 scales; the normally scaled base of caudal, and non-protruding interhaemal spines in both sexes; and the large black caudal spot, followed by a whitish area on both lobes of the caudal fin.

The following counts and proportions are based on seven specimens (unless otherwise stated), ranging in length from 27 to 50 mm.:

Head 3.6 to 4.3; depth 2.6 to 2.9; D. 10 or 11; A. 22 or 23; P. 10 or 11; scales 5 or 6–30 to 33–5; vertebrae 12 or 13+16 or 17 (two specimens examined). Distance from snout to dorsal 1.8 to 2 in standard length; base of anal 3.4 to 4; pectoral 4.5 to 5.3. Snout 5.1 to 5.6 in head; eye 2.8 to 3.2; interorbital 2.8 to 3.5. Premaxillary

teeth in a single series, consisting of 10 to 12 multicuspid teeth expanded at tips, with none of the cusps especially enlarged; maxillary with 2 low multicuspid teeth; mandible with 10 or 12 broad multicuspid teeth with expanded tips that overlap more or less.

Breder (1927, p. 118), who reported many specimens from several places in the Chucunaque Basin, remarks concerning their occurrence, "Taken only above the head of tide, becoming more abundant as the headwaters were approached, generally being found in large schools in quiet and comparatively deep pools."

This species is known from both slopes of central Panama and the Tuyra Basin of eastern Panama.

Gephyrocharax Eigenmann.

This genus is recognized by the strongly compressed body; the strongly rounded ventral outline; the long anal (consisting of 29 to 32 rays in Panama species); the posteriorly inserted dorsal fin, which has its origin behind that of the anal; the presence of two series of teeth on the premaxillaries; the broad second suborbital covering the entire cheek; and the peculiar "spur" formed by the lower free fulcra of the caudal in the male.

The differences among the three species taken in Panama are shown in the accompanying parallel.

DISTINGUISHING CHARACTERS OF PANAMA SPECIES OF GEPHYROCHARAX

atricaudata	*intermedius*	*whaleri*
Profile from snout to occiput slightly convex; a definite off-set at mouth.	Profile as in *atricaudata*.	Profile from tip of snout to occiput straight, no off-set at mouth.
Gape and lower lip notably below dorsal outline of head; not entering into the general profile of head.	Gape as in *atricaudata*.	Gape and lower lip on level with upper lip; entering into the nearly straight dorsal profile of head.
Lower lip thin.	Lower lip as in *atricaudata*.	Lower lip broader and more or less fleshy.
Pectoral fin long, generally reaching to or beyond middle of ventral, 3.7 to 4.25 in standard length, average in 21 specimens 3.9.	Pectoral shorter, generally failing to reach middle of ventral, 4 to 4.5 in length, average in 19 specimens 4.25.	Pectoral long, as in *atricaudata*, 3.6 to 4.1 in standard length, average in 21 specimens 3.78.
Dorsal fin low, failing to reach adipose by 1 or 2 rows of scales if deflexed.	Dorsal fin as in *atricaudata*.	Dorsal fin high, reaching to or beyond origin of adipose if deflexed.
Caudal spot not followed by a whitish area on each lobe of the fin. Outer rays of caudal black.	Caudal spot followed by a whitish area on each lobe of the fin. Outer rays of caudal not black.	Color as in *intermedius*.

Gephyrocharax atricaudata (Meek and Hildebrand).

Gephyrocharax atricaudata Meek and Hildebrand, Field Mus. Nat. Hist., Zool. Ser., **10**, p. 68, 1912—Rio Frijoles, Canal Zone; p. 277, 1916.

Many specimens were collected in 1935 and 1937. A particularly fine lot was taken in the Rio Cocoli, a short distance from Miraflores Lake, but none in the lake itself. Some of these specimens are larger than any previously seen, ranging upward to 65 mm. in length. The species was secured also in Gatun Lake near Gatun; a short distance below Madden Dam; in the present mouth of the Rio Boquerón, above Madden Lake; in a small stream, formerly a tributary of the Chagres, on Madden Dam Road; in an abandoned reservoir at Mount Hope; in a swamp at the La Jagua Hunting Club; and in the Rio Pacorá and the Rio Cabra on the Panama City-Chepo Road.

G. atricaudata occurs on both slopes of central Panama, but is replaced by two other species of the genus in the coastal streams between Campaña and La Venta. As this fish naturally inhabits both slopes of central Panama it is impossible to determine from specimens whether it uses Pedro Miguel Locks (wherein it was not found) as a passageway, though that is not improbable.

This species was quite accurately described by Meek and Hildebrand (1916, p. 277), though no mention was made of the seemingly somewhat longer pectoral fin than in *intermedius*, with which it is very closely related in structure. The following proportions and counts are based on eight specimens, unless otherwise stated, ranging in length from 43 to 65 mm.:

Head 4.2 to 4.5; depth 2.8 to 3; D. 9; A. 31 or 32; P. 10; scales 7-38 to 41-5; vertebrae 10 or 11+24 or 25 (three specimens examined). Snout 3.8 to 4.6 in head; eye 3 to 3.4; interorbital 2.7 to 3.1. Distance from snout to dorsal 1.5 to 1.7 in standard length; base of anal 2.8 to 3; pectoral 3.7 to 4.25 (21 specimens examined).

Breder (1927, p. 125), who reported this species from several places in the Chucunaque Basin, found considerable variation in color, showing some intergradation with *G. intermedius*. No intergradation seems to exist among the material from central Panama. A difference in the proportionate length of the pectoral fins in the two species is shown in the parallel on page 252.

G. atricaudata is common in the Chagres Basin, and on the Pacific slope from the Canal Zone eastward to the Tuyra Basin.

Gephyrocharax intermedius Meek and Hildebrand.

Gephyrocharax intermedius Meek and Hildebrand, Field Mus. Nat. Hist., Zool. Ser., **10**, p. 278, 1916—Rio Chame.

This species was described from the Rio Chame, where at that time (1911) *G. whaleri* was not secured. On March 10, 1937, while en route from Balboa to La Venta several stops were made for the purpose of collecting specimens in a half dozen or more small coastal streams crossing the National Highway between Campaña and La Venta. The specimens from the different streams were not kept as separate collections. Of this species 23 were taken. Whether these specimens are all or in part from the Rio Chame, the type locality, cannot be stated. Neither is it known whether any of the new species, *whaleri*, herein described, were taken in the Rio Chame, as the species was not recognized in the field.

The original description (Meek and Hildebrand, 1916, p. 278) of this species is essentially correct. However, it was not pointed out that the pectoral fins apparently are slightly shorter than in *atricaudata*. Nor was it stated that the caudal spot is followed by a whitish area on each lobe of the fin. Unless otherwise stated the following proportions and counts are based on six specimens taken March 10, 1937:

Head 4 to 4.3; depth 3.1 to 3.4; D. 9; A. 29 to 31; P. 9 or 10; scales 7–36 to 40–5; vertebrae 12+22 (one specimen examined). Snout 4.3 to 4.7 in head; eye 2.8 to 3.5; interorbital 2.6 to 3.2; distance from snout to dorsal 1.6 in standard length; base of anal 2.8 to 3.1; pectoral 4 to 4.5 (19 specimens examined).

This fish inhabits the Rio Chame and probably neighboring coastal streams.

Gephyrocharax whaleri sp. nov.

Type from Rio Chame or a near-by stream, Pacific slope, Panama. No. 106513 United States National Museum. Total length 53 mm., standard length 40 mm.

Description of the Type.—Head 4.2; depth 3.1; D. 9; A. 32 (including 3 undivided rays); P. 11; scales 6–35–5.

Body strongly compressed; the ventral outline very convex anteriorly, the dorsal profile straight and nearly horizontal from snout to occiput, gently convex posterior to occiput; snout shorter than eye, 4.1 in head; eye 3; interorbital 2.7; mouth strongly oblique, superior, the lower lip in advance of the upper one, entering into the general dorsal profile; maxillary ascending almost vertically close in front of eye, scarcely extending beyond anterior margin of orbit; lower lip rather broad and fleshy; premaxillary teeth in 2 series, the outer series incomplete and smaller than inner series; maxillary with

2 small teeth; mandible with a single series of teeth, enlarged on anterior part of jaw with abruptly smaller ones on each side; gill rakers very short, mere points, 12 on lower limb of first arch; lateral line strongly decurved; scales moderate, the series only fairly regular; dorsal fin inserted posteriorly, equidistant from base of caudal and shoulder spot, distance from snout to dorsal 1.6 in standard length, the fin high with longest rays reaching adipose if deflexed; adipose over base of last rays of anal; caudal fin rather deeply forked; anal fin long, its origin fully an eye's diameter in advance of dorsal, its base 3 in standard length; ventrals moderate, reaching origin of anal;

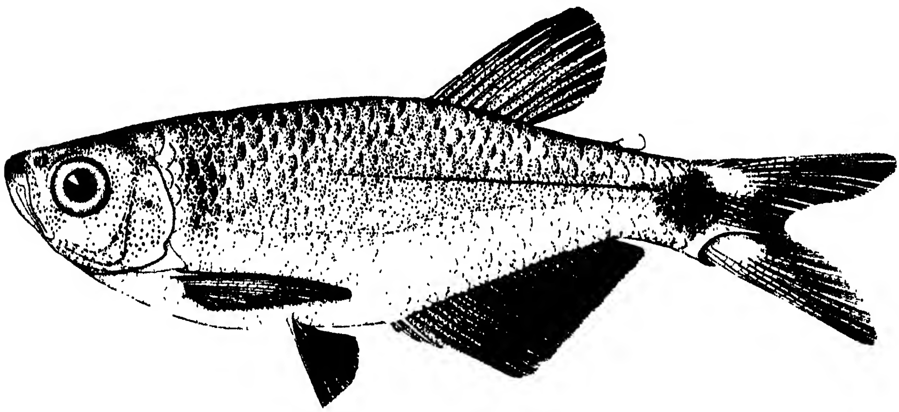

FIG. 2. *Gephyrocharax whaleri* sp. nov. Type, male, 53 mm. long. (From drawing by Louella E. Cable.)

pectorals long, reaching somewhat beyond mid-length of ventrals, 3.6 in standard length.

Color greenish with silvery luster above, plain silvery below. Base of caudal with a prominent spot, followed by a whitish area, the black not extending on fin; a prominent vertically elongate shoulder spot present, extending nearly from the nape to behind base of pectoral; fins plain colorless except for dusky points.

Variations noticed in the paratypes are as follows: Head 3.75 to 4.2; depth 3 to 3.2; A. 30 to 32 (including undivided rays); P. 10 or 11; scales 6 or 7–35 to 38–5, before dorsal 17 to 20; vertebrae 10 or 11+23 or 24 (three specimens examined). Snout 3.7 to 4.4 in head; eye 2.8 to 3.4; interorbital 2.7 to 3.2. Distance from snout to dorsal 1.5 to 1.6 in standard length; base of anal 2.8 to 3; pectoral 3.6 to 4.1 (21 specimens measured).

The teeth are seen with difficulty without removing the jaws. Those in the upper jaw are in 2 series. The outer series is irregular and consists of 2 to 4 small tricuspid teeth on each side, with none in front of the 2 anterior (middle) teeth in second row. The second series is regular and the teeth are larger, with 4 or 5 teeth, each with 3 to 5 cusps. Maxillary anteriorly with 2 very small tricuspid teeth. Mandible with 4 enlarged teeth on each side, followed by abruptly smaller ones. The enlarged teeth with 3 to 5 cusps, the middle cusp long and pointed.

This species is represented in the collection by 50 specimens (including 23 males), ranging in length from 26 to 65 mm. These specimens are probably not all from one stream, as collections of fish were made in the Rio Chame and several smaller near-by coastal streams crossing the National Highway between Campaña and La Venta. The several collections were not kept separate.

This species agrees in color with *intermedius*, its nearest relative inhabiting the Rio Chame and probably other near-by streams. It differs from that species in the more nearly vertical mouth and thicker lower lip, which extends upward and enters into the straight dorsal profile of the head, whereas the lower lip in *intermedius* is lower than the upper one (as in *atricaudata*), causing a decided break at the mouth in the general dorsal outline of the head. The thickened lower lip seems to be normal in *G. whaleri*, and has not been noticed in any of the many specimens of the other species of the genus examined, though in some other genera (*Astyanax* and *Brycon-americus*) of characins it does not seem to have any specific significance. The dorsal fin is notably higher (in both sexes) in *whaleri* than in the other local species of the genus, reaching to or a little beyond the origin of the adipose if deflexed, whereas in *intermedius* and *atricaudata* it fails to reach the adipose by 1 or 2 rows of scales. The specific differences among the three local species of *Gephyro-charax* shown in the accompanying parallel.

I take pleasure in naming this species for my friend, Fred Whaler of Balboa, Canal Zone, who is an ardent angler as well as a student of fishes, and who rendered valuable assistance when the specimens were taken.

Astyanax Baird and Girard. SARDINAS DE MONTAÑA.

This species of this genus are small, compressed, rather deep-bodied fishes, the depth generally being contained, more than 2 times in the length to the base of caudal. The teeth in the premaxillaries

are in 2 even rows, each row with 8 teeth in Panama species. The lower jaw has strong teeth (8 in Panama species) anteriorly, followed on each side by abruptly smaller ones. The maxillary has a few (2 in Panama species) small teeth at its juncture with the premaxillary, or none. The second suborbital is rather narrow, not coming in contact with the lower limb of the preopercle, and it leaves a small naked triangular area at its juncture with the first suborbital. The lateral line is complete, and scales (all normal) do not extend far on the base of the caudal. The vertebrae in Panama species are 14+17 or 18. Five species are known from Panama, one of them being new and herein described.

Astyanax fasciatus (Cuvier).

Chalceus fasciatus Cuvier, Mem. Mus. Paris, **5**, p. 352, 1819 Brazil.

Astyanax fasciatus Meek and Hildebrand, Field Mus. Nat. Hist., Zool. Ser., **10**, p. 280, 1916.

Specimens recently collected in central Panama, as well as those collected there and in eastern Panama by us in 1911 and 1912, differ prominently from specimens of the extremely abundant *A. ruberrimus* in the absence of a black caudal spot. *A. fasciatus* also differs, so far as Panama material at hand is concerned, in being slightly deeper, in having a larger number of longitudinal rows of scales, and in reaching a somewhat larger size. Both species vary considerably in depth, causing the proportional measurements to overlap. An average difference exists, however, as in 26 specimens of *A. fasciatus* measured the range of the depth in standard length is 2.2 to 2.7, and the average 2.42. In 67 specimens of *ruberrimus* the range is 2.25 to 3.1, and the average 2.66. *A. fasciatus* apparently nearly always has 8 rows of scales between the lateral line and the base of the first dorsal ray, and 7 between the lateral line and the base of the ventral. In 27 specimens examined two specimens differ, one having 7 rows above the lateral line, and another having 6 rows below it. In 30 specimens of *ruberrimus* constantly 7 rows above the lateral line and 5 or 6 (usually 6) below it were counted. Specimens of *fasciatus* up to 150 mm. in length were taken, but none of *ruberrimus* exceeding 110 mm.

Breder (1927, p. 122) found it difficult to separate his specimens from the Rio Chucunaque into two species and expressed doubt concerning the validity of *fasciatus* and *ruberrimus*. Eigenmann (1921, p. 306) placed the Panama specimens, identified by Meek and Hildebrand (1916, p. 280), as *fasciatus*, in the subspecies *aeneus*, which according to his key falls into the group having a dusky or

black band extending to the end of the middle rays of the caudal fin. No such band is present in any of our Panama specimens. Behre (1928, p. 319) recorded *A. aeneus costaricensis* Meek from extreme western Panama (Atlantic slope). This subspecies apparently is a synonym of *A. fasciatus aeneus* as understood by Eigenmann. I am obliged to regard the identity of the Panama material from the Pacific slope with that of the Atlantic slope of western Panama and Costa Rica as very doubtful.

Specimens were collected in 1935 and 1937 at the La Jagua Hunting Club, in the Rio Pacorá and the Rio Cabrá, and in other small coastal streams along the Panama City-Chepo Highway. One fine specimen, 107 mm. long, was taken in a creek, formerly tributary to the Rio Chagres, now flowing into Gatun Lake, not far from Madden Dam. As this species was not taken in the Atlantic drainage during the extensive collecting done on the Canal Zone and vicinity in 1911 and 1912, before the opening of the Canal, it seems probable that it has "migrated" through Culebra Cut from the Rio Grande Basin of the Pacific slope.

This species and its various subspecies or varieties, as now understood, range from Mexico through Panama and Colombia to Brazil.

Astyanax ruberrimus Eigenmann.

Astyanax ruberrimus Eigenmann, Indiana Univ. Studies, No. 18, p. 25, 1913—Istmina, Atlantic slope, Colombia; Meek and Hildebrand, Field Mus. Nat. Hist., Zool. Ser., **10**, p. 281, 1916.

The relationship of this very common species, inhabiting both slopes of Panama and Colombia, is discussed under *A. fasciatus* and *A. kompi*. It is most readily recognized by its large black caudal spot, which does not extend to the end of the caudal rays; and by the moderate number, namely 7, of longitudinal rows of scales between the lateral line and the base of the first dorsal ray, and 5, or more commonly 6, rows between the lateral line and the base of the ventral. It rarely exceeds a length of 100 mm. (4 inches), the usual length being around 75 mm. (3 inches).

Specimens were collected at the La Jagua Hunting Club, and in various Pacific slope streams along the Chepo Highway near Panama City; also, at Campaña in the Rio Capira, in several streams crossing the National Highway between Campaña and La Venta, and in a small stream along the road to El Valle, but not in El Valle. Many specimens were seined in the Rio Cocoli and Miraflores Lake. Others from the Pacific drainage are from Fort Kobbe, and Albrook Flying Field. In the Atlantic drainage this species was taken in the

Rio Boquerón, above Madden Lake, and in Madden Lake; in some small creeks crossing Madden Dam Road; in Chillibrillo Cave (where this species and a catfish, *Rhamdia wagneri*, only were found); in Gatun Lake at Gatun, Gamboa, a short distance below Madden Dam, at Saddle Ridge, and Barro Colorado Island, and various places in the open lake; in abandoned reservoirs at Gatun and Mount Hope; and in running streams at Fort Sherman (Toro Point), and Cativa.

This species is common and may be seen and taken almost anywhere in streams, swamps, and lakes of central and eastern Panama. It is the most numerous of all fresh-water fishes of the Canal Zone, having become exceedingly abundant in Gatun and Miraflores lakes. A small piece of bread, banana, meat, or other food, thrown into the water, brings dozens of these little fish to the surface almost immediately. It is chiefly this species that nibbles at the bather if he remains quiet in the water for a few seconds.

The large notched teeth and short intestine suggest an animal diet. However, in addition to insects, crustaceans, and occasionally a small mollusk, much debris is generally present, some of which can often be identified as of vegetable origin. Other parts of the debris sometimes consist of small flakes of meat, no doubt from animals too large to swallow whole. The large rasping teeth are well suited to cutting bites of meat from other animals. For their size these little characins probably are no less ferocious than the distantly related piranhas (the man-eating fishes) of the Amazon and Orinoco rivers, and it is believed that they are responsible chiefly for the failure of the several introductions of food and game fishes in Gatun Lake by the United States Bureau of Fisheries.

As this species was common in both the Rio Chagres and Rio Grande basins before the opening of the Canal it is impossible to determine from the collections whether it uses the Pedro Miguel Locks as a passageway. However, as some of the other characins, and especially *A. fasciatus*, almost certainly at times do pass through the Pedro Miguel Locks, it seems probable that this common species likewise passes through them, though none was seen in the locks when dewatered during the writer's presence, February 20, 1937.

Charles M. Breder of the New York Aquarium, who has collected extensively in Panama, some years ago called my attention in correspondence to the fact, which I also had noticed, that nearly all adult *ruberrimus* from the Pacific slope have reddish fins, whereas those from the Atlantic have yellowish fins. In 1935 and 1937 I gave special attention to this difference in color. I failed to find adults

in the Pacific slope without pink or red fins, but I did find some specimens on the Atlantic side that had them. For example, I caught several specimens in Gatun Lake at Gatun with reddish fins. It might be supposed that these fish had come through the Canal from the Pacific side. However, I also secured several specimens with reddish fins in an abandoned reservoir at Mount Hope and in a running stream at Cativa, localities entirely separate from the Canal. This rather usual difference in color, then, seems to be of no specific significance.

Breder (1927, p. 120) recorded many specimens from various localities in the Chucunaque Basin. He examined a large number of stomachs for food content and found about the same foods as those reported above for specimens from central Panama.

This very common fish of central and eastern Panama, according to Eigenmann (1922, p. 144) ranges into Colombia only on the Pacific slope. Dr. Behre (1928) did not report it from western Panama, and my record (1928, p. 83) based on specimens from the lagunas Verde, Grande, and Gulnar, Chiriquí, proves to be an error, as further study has shown that the fish belong to a distinct species, herein named *A. kompi.*

Astyanax kompi sp. nov.

Astyanax ruberrimus Hildebrand (not Eigenmann), Copeia, No. 168, p. 83, 1928.

Type from Laguna Gulnar or Grande, Volcán, Pacific slope, Panama. No. 106510 United States National Museum. Length 70 mm. Also 46 paratypes, length 18 to 80 mm.

Description of the type.—Head 3.8, depth 3.2, D. 10, A. 27, scales 35. Body compressed, moderately elongate; head short; snout blunt, notably shorter than the large eye, 4.4 in head; eye 3.1; interorbital 3; mouth small, jaws subequal; maxillary a little beyond anterior margin of pupil, forming an obtuse angle with the premaxillary, slightly longer than snout and a little shorter than eye; premaxillary teeth in 2 regular series, each with 8 teeth, those of the second series larger, all premaxillary teeth with 3 to 5 cusps; maxillary anteriorly with 2 small teeth; lower jaw with 8 strong teeth having 3 to 5 cusps, followed on each side by abruptly smaller teeth; gill rakers short, 12 on lower limb of first arch; lateral line complete, moderately decurved; scales rather large, 10 between dorsal and adipose, 6 complete rows of scales between the lateral line and base of anterior rays of dorsal, and an equal number between the lateral line and base of ventral;

origin of dorsal not quite an eye's diameter nearer tip of snout than base of caudal; adipose over end of base of anal, rather more than half as far from base of caudal as from end of base of dorsal; caudal fin moderately forked, the lower lobe only slightly longer than the upper one, about as long as head; anal rather long, its base about equal to length of head, 3.8 in standard length, its origin just posterior to base of last ray of dorsal; ventral fins scarcely to origin of anal, inserted a little less than half an eye's diameter in advance of dorsal; pectoral failing to reach ventral by one row of scales, 1.2 in head.

Color mostly silvery; with a fairly distinct dusky lateral band, nowhere as wide as eye, ending in a prominent, elongate black caudal spot, with a slight indication of the black extending to end of middle

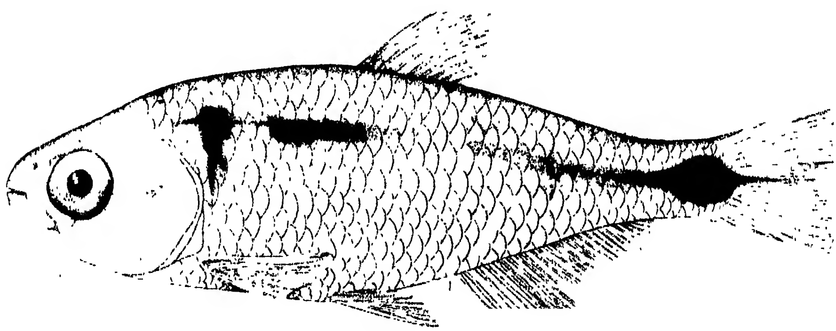

FIG. 3. *Astyanax kompi* sp. nov. Type, 70 mm. long. (From drawing by Andrew Pizzini.)

caudal rays; humeral spot prominent, with a downward projection, extending on second row of scales below lateral line; a second less distinct spot somewhat less than an eye's diameter behind the first; opercle dusky; fins mostly translucent, without definite markings.

The variations noticed in the paratypes are as follows: Head 3.5 to 3.9, depth 3 to 3.7, D. 10 or 11, A. 27 to 30, scales 6-33 to 36-6, vertebrae 14+17 or 18 (four specimens dissected); snout 4 to 4.8 in head; eye 3 to 3.3, interorbital 2.8 to 3.3, pectoral 1.2 to 1.4.

No variation in the number of teeth has been found. The exact shape of the 2 maxillary teeth cannot be seen without removing the maxillary for examination under the microscope. It then becomes evident that the first tooth has a long base with 6 or 7 cusps, and the second one, which is smaller, has 3 or 4 cusps.

The origin of the dorsal, though nearly an eye's diameter nearer tip of snout than base of caudal in the type, is more usually about equidistant from these points in the paratypes. The base of the anal is equal to or a little longer than the head, 3.7 to 4.7 in standard length. In the young the ventrals reach the origin of the anal, and the pectorals to or a little beyond the base of ventrals. These fins do not reach quite as far in adults.

If the scales are counted in exactly the same place each time there is remarkably little variation. In fact, there are constantly 6 longitudinal series between the lateral line and the base of the anterior dorsal ray, and a like number between the lateral line and base of ventral, in 21 specimens examined.

The color is remarkably uniform in specimens of equal size. However, in the young the lateral band is proportionately narrower, and in the very young the second humeral spot is missing. The caudal spot does not occupy the entire width of the caudal peduncle, as in young *A. ruberrimus*. In life the fish were greenish above, sides and below bright silvery, and the fins mostly pinkish.

The fish were taken in part in Laguna Gulnar and in part in Laguna Grande (renamed Davis in honor of a former United States minister to Panama), the catches not being kept separate. This species is the only characin that was secured. It was abundant in both lakes at the time of my visit (February 7, 1935).

The lakes are at an elevation of about 4,500 feet, and supposedly occupy craters of extinct volcanoes. The temperature of the water at the surface, near shore, was 75° F. in each lake in mid-afternoon on February 7, 1935.

The characin taken is close to *A. ruberrimus*, and specimens collected in these lakes by Fred J. Foster in 1924 were so recorded by me (1928, p. 83). However, a further study, based on a larger number of specimens, shows the Volcán specimens to differ sufficiently to be entitled to recognition as representatives of a distinct species which is apparently new. The specimens from Volcán are more slender, have larger eyes, and fewer rows of scales above the lateral line.

The range of the depth in the standard length in 34 Volcán specimens measured is 3 to 3.7, the average for these specimens being 3.28, whereas in 67 specimens of *ruberrimus* from various localities of both slopes of central Panama the range is 2.25 to 3.1, with an average of 2.66. The measurements, therefore, overlap slightly. However, only four specimens of *ruberrimus* are slender enough to

come within the range of the Volcán material. Usually the two species, then, may be separated at once by the difference in the depth of the body.

The number of longitudinal rows of scales above the lateral line is remarkably constant in both species. In 23 specimens from Volcán counted there are constantly 6 complete scales between the lateral line and the base of the first ray of the dorsal, whereas in 30 specimens of *ruberrimus* from various localities of central Panama there are constantly 7. It is imperative that the scales be counted in exactly the same place in each species in order to show the difference of the single row mentioned.

The larger eye in the Volcán material is evident at once if specimens of equal size are compared, but cannot be well demonstrated by measurements of specimens of various sizes. In specimens ranging from about 50 to 80 mm. in length the eye is contained in the head about 2.8 to 3.1 times in the Volcán specimens, and 3.2 to 3.9 times in Canal Zone material.

The writer takes pleasure in naming this species for the distinguished medical entomologist of the United States Public Health Service, W. H. W. Komp, who accompanied the author in his investigations in the Volcán region.

Astyanax nicaraguensis Eigenmann and Ogle.

Astyanax rutilus nicaraguensis Eigenmann and Ogle, Proc. U. S. Nat. Mus., 33, p. 23, 1907—Nicaragua.

This rather doubtfully distinct species is included because of a record by Behre (1928, p. 319), who listed it from some small streams on the Atlantic slope of extreme western Panama in the Province of Bocas del Toro.

This imperfectly understood species seems to differ from *albeolus* chiefly in the position of the dorsal fin, which has its origin about equidistant from the tip of the snout and the base of the caudal. It has 2 to 8 teeth on the maxillary, 27 to 32 anal rays, and 32 to 40 scales in the lateral series. The caudal band (not spot), as in *albeolus*, extends to the end of the middle rays of the caudal.

The range, as reported, extends from Nicaragua to extreme western Panama. The genus *Astyanax* of Central America seems to require much more study to determine the relationships and distribution of the species.

Astyanax albeolus Eigenmann.

Astyanax albeolus Eigenmann, Bull. Mus. Comp. Zool., 52, p. 97, 1908—Rio Machuca, Costa Rica.

This species is included in the Panama fauna on the basis of a record by Behre (1928, p. 319) who listed it from the Rio Chiriquí del Tire, near Caldera (Pacific slope), Chiriquí, Panama, with the remark: "These fishes seem to differ from Eigenmann's *A. albeolus* only in that the body is slightly less compressed and more shallow, and that the anal fin count is occasionally below the type."

It apparently differs from *kompi*, the nearest relative among Panama fishes, in the deeper body; smaller scales; the more anterior insertion of the dorsal, which begins more than an eye's diameter nearer to the tip of snout than to base of caudal; and in color, the black lateral band (not a black caudal spot) extending prominently to the end of the middle rays of the fin, wherein it also differs from other *Astyanax* from Panama, exclusive of *nicaraguensis*.

The following counts and proportions are from Eigenmann (1921, p. 290): Head 4.5; depth 2.66; D. 11; A. 26 to 30; scales 7–38–7; eye equal to snout, 3.5 in head.

The species, prior to Dr. Behre's record, was listed only from Costa Rica.

Bryconamericus Eigenmann. SARDINAS DE MONTAÑA.

This genus is close to *Astyanax*, from which it differs in having a broader second suborbital, which is in contact with the lower limb of the preopercle, and does not leave a small naked triangular area at its suture with the first suborbital. The teeth in the premaxillaries are in 2 series as in *Astyanax*, but the first series has 10 instead of 8 teeth (Panama species) and they are in an uneven row (at least in Panama species). On the maxillary, at its juncture with the premaxillary, there are 2 or 3 very small teeth with roundish base, whereas *Astyanax* from Panama have 2 small teeth in the same position, but each with a long base, the first one especially being very elongate. In Panama specimens of *Bryconamericus*, at least in *emperador* and *zeteki*, the vertebrae are a little more numerous, the formula being 15+20 or 21, whereas that for *Astyanax* is 14+17 or 18.

Bryconamericus emperador (Eigenmann and Ogle).

Astyanax emperador Eigenmann and Ogle, Proc. U. S. Nat. Mus., **33**, p. 26, 1907—Empire, Canal Zone.

Bryconamericus emperador Meek and Hildebrand, Field Mus. Nat. Hist., Zool. Ser., **10**, p. 283, 1916.

Specimens were secured in 1935 and 1937 in the upper part of Gatun Lake (near Madden Dam), at Barro Colorado Island, and in a small stream on Madden Dam Road, tributary to Gatun Lake.

None were taken in Miraflores Lake, nor in the other waters sampled on the Pacific slope during the recent investigations. Meek and Hildebrand (1916, p. 284) remarked concerning the distribution: "It occurs on both slopes of Panama, and is always found in company with *Astyanax ruberrimus*, but much less abundant, except in the Rio Tuyra Basin where it outnumbers the latter." Breder (1927, p. 123), however, found *A. ruberrimus* more numerous than *B. emperador* in the Río Chucunaque, a tributary of the Rio Tuyra in which we could not collect in 1912, when several other tributaries were sampled. Breder (1933) did not name this species in his list of fishes from Barro Colorado Island, and Dr. Behre (1928) did not obtain it in western Panama.

As this species occurs naturally on both slopes of central Panama, and as it was not taken in Miraflores Lake during the recent investigations no information was secured relative to its use of the locks as a passageway.

It occurs on both slopes of central Panama and in the Tuyra Basin. Costa Rica records probably are referable to *B. terrabensis* Meek (1914, p. 108).

Bryconamericus zeteki sp. nov.

Type from a creek in El Valle, Pacific slope, Panama. No. 106511 United States National Museum. Length 88 mm. Also 59 paratypes, length 20 to 88 mm.

Description of the type.—Head 4, depth 3.1, D. 11, A. 26, scales 36.

Body compressed, moderately deep; head short; snout shorter than eye, 3.9 in head; eye 3.2; interorbital 3.2; mouth small; lower jaw a little shorter than upper one; lower lip quite broad and thick, exceeding half the width of pupil; maxillary a little beyond anterior margin of pupil, forming an obtuse angle with premaxillary, notably longer than snout and nearly as long as eye; premaxillary with 2 series of teeth, the outer series with 10 teeth in an irregular row, alternating teeth being set farther forward, the inner series with 8 teeth set in an even row and notably larger than those of the outer series, all premaxillary teeth notched, having from 3 to 5 cusps; maxillary with 3 very small teeth anteriorly, having very low blunt cusps; lower jaw with 8 large teeth, having 3 to 5 cusps, followed on each side by abruptly smaller teeth; gill rakers small, about half length of pupil, 11 on lower limb of first arch; lateral line complete, moderately decurved, not wavy; scales moderately large, in regular series, 6 complete rows between lateral line and base of anterior

rays of dorsal, and 5 between lateral line and base of ventral, 11 rows crossing back between dorsal and adipose, normal scales extending somewhat on base of caudal; dorsal fin rather high, with nearly straight margin, its origin equidistant from tip of snout and base of caudal; adipose very small, its base occupying only 1 row of scales, over beginning of posterior fourth of anal; caudal fin rather broadly forked, the lower lobe slightly longer than the upper one, scarcely as long as head; anal fin moderately long, with concave margin, its origin slightly posterior to base of last ray of dorsal, its base a little longer than head, 3.6 in standard length; ventrals small, extending slightly past vent, but failing to reach origin of anal, inserted rather less than an eye's diameter in advance of dorsal; pectorals failing to reach ventrals by 1 row of scales, 1.25 in head.

Color of preserved specimen brownish above, median line of back darker; lower parts pale silvery; humeral spot faint; a rather prominent lateral band, extending forward to upper anterior angle of gill opening, widest and most prominent posteriorly, ending in a caudal spot, which extends on base of caudal fin, and indefinitely to end of middle rays; body everywhere, except underneath, with dusky punctulations. Fins unmarked, except for dusky punctulations on the vertical ones, and on the outer rays of the pectorals. All enlarged teeth in both jaws with dark tips.

The variations noticed in the paratypes are as follows: Head 3.6 to 4, depth 2.9 to 3.1, D. 10 or 11, A. 25 to 27, scales 6 (rarely 7)—35 to 38–5, vertebrae 15+20 or 21 (6 specimens dissected), snout 4 to 4.5 in head, eye 2.75 to 3.3, interorbital 2.9 to 3.4, caudal peduncle 2.1 to 2.5, pectoral 1.15 to 1.25.

No variation in the number and arrangement of the enlarged teeth in the premaxillaries and mandible has been noticed. However, the teeth on the maxillary vary from 2 to 3, and have a roundish base, instead of an elongate one as in specimens of *Astyanax* described elsewhere. The second suborbital is uniformly wide and nearly or quite in contact with the lower limb of the preopercle, not leaving a naked triangular area between the suture of the first and second suborbitals as in *Astyanax;* from two-thirds to nearly as wide as eye at its broadest place. The pectorals in small specimens (under about 50 mm. in length) reach a little farther back (to base of ventrals) than in larger ones, as usual in young fish. In the young the lateral band is narrower and more clearly defined, and the caudal spot extends definitely to the end of the caudal rays. All the enlarged

teeth in the jaws have brownish tips, becoming darker to almost black in large examples.

The specimens from El Valle, here described, are close to *B. emperador* of central and eastern Panama, but they differ in having the scales in more regular series and in fewer longitudinal rows, in having thicker and broader lips, a slightly smaller eye, and rather shorter pectorals; and they also differ slightly in color.

In 22 specimens from El Valle only two individuals have 7 complete rows of scales between the lateral line and the base of the anterior rays of the dorsal, all the rest having 6. Between the lateral line and the base of the ventral 5 complete rows are constantly present in the 22 specimens examined. In 15 specimens of *B. emperador* from the Canal Zone, in which the rows are more difficult to enumerate because of their unevenness, 7 rows were counted between the lateral line and the base of the anterior rays of the dorsal in nine specimens, and 8 rows in the other six. Six rows were counted in all these fish between the lateral line and the base of the ventral. No difference in the number of scales in the lateral series seems to exist.

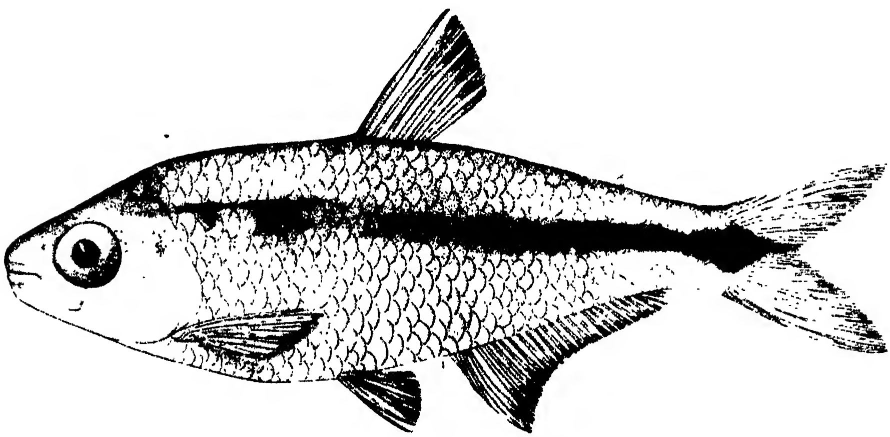

FIG. 4. *Bryconamericus zeteki* sp. nov. Type, 88 mm. long. (From drawing by Andrew Pizzini.)

The lower lip in the El Valle specimens is obviously thicker and broader, being fully half as wide as pupil, whereas in Canal Zone specimens (*B. emperador*) it is thinner and narrower, being scarcely half as wide as pupil. This difference might conceivably be due to a difference in preservation. However, the writer preserved all the specimens studied by the same method, the only difference being

that the Canal Zone specimens have been in alcohol longer, having been collected two years earlier.

That the eye is slightly smaller in the El Valle specimens is evident only if specimens of equal size are compared. In a series of measurements, based on various sizes, the porportions overlap. However, in specimens ranging in length from about 70 to 90 mm. the eye is contained in the head about 3.1 to 3.3 times in the El Valle material and 2.7 to 3 times in the Canal Zone specimens.

The pectoral fins fail to reach the base of the ventrals, except in the young, in the El Valle material as already shown, whereas in the Canal Zone specimens the pectorals reach to or beyond the base of the ventrals in all except very large specimens of 100 mm. and upward in length.

In color the El Valle specimens differ in having the caudal spot extending more or less definitely to the end of the middle rays of caudal, whereas in Canal Zone specimens it projects only slightly on the base of the caudal rays. The tips of the teeth are not brown or black in *B. emperador* as in the El Valle specimens.

Northward three species of this genus, *scleroparius*, *terrabensis* and *ricae*, all from Costa Rica, are known. The first is known also from Nicaragua and the last extends slightly into western Panama. The El Valle specimens seem to differ in having a rather more slender body, rather shorter anal, more posteriorly placed dorsal, and more elongate caudal spot, which extends to the end of the middle caudal rays.

I have designated the El Valle specimens a distinct species, though their close relationship with *B. emperador* makes it questionable whether they should be considered distinct, or only a subspecies of *emperador*.

I take pleasure in naming this fish for Professor James Zetek, the well-known naturalist of the Canal Zone and Panama.

Bryconamericus cascajalensis Meek and Hildebrand.

Bryconamericus cascajalensis Meek and Hildebrand, Field Mus. Nat. Hist., Zool. Ser., **10**, p. 284, pl. 19, 1916—Rio Cascajal, Porto Bello, Panama.

Known only from the type material from Porto Bello.

Bryconamericus ricae Eigenmann.

Bryconamericus peruanus ricae Eigenmann, Bull. Mus. Comp. Zool., **52**, p. 106, 1908—Rio Chitaria, tributary of Rio Reventazon, Atlantic slope, Costa Rica.

This form is included in the fauna of Panama on the basis of a record by Behre (1928, p. 320), who listed it from the Atlantic slope

of extreme western Panama, province of Bocas del Toro, under the name *B. peruanus ricae*. However, Eigenmann (1927, p. 393) raised *ricae* to full specific rank. It differs from the other Panama species herein recognized in the more anterior position of the dorsal fin, the origin of which is described as being an eye's diameter nearer to snout than base of caudal. It seems probable from published accounts that *ricae* may have somewhat more numerous scales and anal fin rays than the other Panama forms, the numbers given being, scales 7–39 to 40–6, anal 28 to 31. A comparison of specimens, which has not been possible, probably would reveal other differences.

Known from the Atlantic slope of Costa Rica, and somewhat across the border in Panama.

Hemibrycon dariensis Meek and Hildebrand.

Hemibrycon dariensis Meek and Hildebrand, Field Mus. Nat. Hist., Zool. Ser., **10**, p. 285, pl. 20, 1916.

Originally described from specimens taken in several different places in the Rio Tuyra and its upper tributaries. Breder (1927, p. 123) recorded *dariensis* from several localities on the Rio Chucunaque and its tributaries. To date it is known only from the Tuyra Basin.

Hyphessobrycon Durbin.

A single species of this genus is known from Panama. The genus is characterized by the short compressed body with elevated back, by the presence of two series of premaxillary teeth, by the incomplete lateral line, and by the naked and unmodified caudal fin in both sexes.

Hyphessobrycon panamensis Durbin.

Hyphessobrycon panamensis Durbin, in Eigenmann, Bull. Mus. Comp. Zool., **52**, p. 101, 1908—Rio Boquerón, Panama; Meek and Hildebrand, Field Mus. Nat. Hist., Zool. Ser., **10**, p. 287, 1916.

Taken only in the Chagres Basin in 1911 and 1912. In 1935 I secured specimens in Gatun Lake near Gatun, and in a small stream flowing into Gatun Lake crossing Madden Dam Road. Behre (1928, p. 318) reported it from some small streams of the Atlantic drainage of extreme western Panama, where it seems to be common.

It is a small species, apparently rarely exceeding a length of 50 mm. It is most readily distinguished from the other small characins of the vicinity by the incomplete lateral line, which is present on only about 8 to 13 scales, and by the rather plain color. This species has no caudal spot, though it does have a narrow dark lateral band, at least on the posterior half of the body. It also has a vertically

elongate dusky shoulder spot, usually followed by a second less distinct spot. Furthermore, it has an ill-defined dark band on the median line of the back. The fins are unmarked, except for dusky punctulations.

The following counts and measurements are based on 6 specimens (unless otherwise stated), ranging in length from 30 to 47 mm.:

Head 3.5 to 3.6, depth 2.5 to 2.8, D. 10 or 11, A. 24 or 25, P. 11 or 12, scales 6 or 7–30 to 33–5 or 6, vertebrae 13+18 (one specimen counted). Distance from snout to dorsal 1.6 to 1.8 in standard length, base of anal 3.2 to 3.4, pectoral 4 to 4.5. Snout 4.5 to 5.5 in head, eye 2.5 to 2.8, interorbital 3.4 to 3.9. Premaxillaries with 2 series of teeth; the outer series with 3 teeth on each side; inner series with 4 larger teeth on each side; maxillary with 2 or 3 very small teeth anteriorly; mandible with 1 series of teeth, with 4 enlarged ones anteriorly on each side, followed by smaller ones; all teeth with 3 to 5 cusps.

The range apparently extends along the Atlantic slope from the Panama-Costa Rica border to the Magdalena Basin in Colombia.

Thoracocharax Fowler.

The species of this genus are characterized by the short, deep, compressed body with a greatly dilated thoracic region, which, together with the abdomen, forms a semicircular disk with a sharply compressed edge. An adipose fin is present, the pectoral fins are large, and the anal long (with 33 to 36 rays in Panama species).

The genus is widely distributed, ranging from Panama southward to Paraguay. The species are rather extensively used as "pet fish" in home aquaria. The peculiarly expanded thoracic region with sharp edge has suggested the name "hatchet fish," which is used by aquarists. The large pectorals and the ability to "skip" some distance over the water has called forth the name "fresh-water flying fish," which also is used by aquarists. Because of the "flying" propensities it is necessary to cover (screen) the aquaria in which these fishes are kept.

Thoracocharax maculatus (Steindachner).

Gasteropelecus maculatus Steindachner, Denkschr, Akad. Wiss. Wien, **41**, p. 168, 1879—Rio Mamoni, Chepo, Panama.

Thoracocharax maculatus Meek and Hildebrand, Field Mus. Nat. Hist., Zool. Ser., **10**, p. 288, 1916.

Taken during the recent investigation, only in swamps at the La Jagua Hunting Club, about 15 miles east of Panama City, where

it was numerous. In 1911 and 1912 we took it in the Chorrera, Bayano and Tuyra basins, but not on the Canal Zone. All the specimens were collected by us either in sluggish or standing water, and mostly in stagnant swamps. However, Breder (1928, p. 125) stated, concerning his collections in the Chucunaque Basin: "Taken commonly only above the head of tide, in some places abundant, especially in fast small side streams."

A collector of "petfish" informed me that this fish could be caught only at night. However, the numerous specimens taken at various places in Panama by us were all seined by day. It is true, nevertheless, that many fish escaped either by skipping and swimming away from the net, or by "flying" over the cork line. Mr. Breder (1928, p. 125) reported some observations concerning "flight." He said that at night, when the fish appear to be most active, they sometimes were seen "to leap in a shoal and travel five feet or more before cutting into the water again. At such times they often rise to a height of six inches or more from the water's surface." Mr. Breder has suggested that it seems probable that the large thoracic muscles may make it possible for the fish to use the enlarged pectoral fins to a limited extent as wings.

Among the many collected at the La Jagua Hunting Club, one specimen, 53 mm. long, which is otherwise normal, is entirely without an adipose fin, the usual place of insertion being scaled over with normal scales.

This species has been taken on the Pacific slope only in Panama, from the Rio Chorrera eastward, but not in the Canal Zone. It ranges into Colombia where it is known from the Rio San Juan on the Pacific side, and the Rio Atrato on the Atlantic.

Creagrutus notropoides Meek and Hildebrand.

Creagrutus notropoides Meek and Hildebrand, Field Mus. Nat. Hist., Zool. Ser., **10**, p. 68, 1912—Rio Indio, upper tributary of Rio Chagres; p. 289, pl. 21, 1916.

Known only from the upper Chagres Basin.

Creagrutus affinis Steindachner.

Creagrutus affinis Steindachner, Denkschr. Akad. Wiss. Wien, **42**, p. 27, 1880—Cauca, near Cáceres.

Creagrutus simus Meek and Hildebrand, Field Mus. Nat. Hist., Zool. Ser., **10**, p. 85, 1913—Rio Cupe, tributary of Rio Tuyra; p. 290, 1916.

This species appears under the name *C. simus* in our earlier general work, as shown above. However, that name was placed in synonymy by Eigenmann (1922, p. 146), though there seemed to

be a small difference in the number of longitudinal rows of scales between Rio Tuyra specimens (*simus*) and Atrato ones (*affinis*).

Mr. Breder (1927, p. 124) recorded 145 specimens, ranging in length from 18 to 58 mm., from several places in the Chucunaque Basin. This fish has been found also in the Tuyra, Atrato, San Juan, and Cauca basins.

Roeboides Günther.

The local species of this genus are readily recognized by the strongly compressed elongate body, which is often almost transparent. In adults the outline is deeply concave over the head. External tooth-like processes project forward from the upper jaw. The anal fin is very long (with 42 to 50 rays in Panama species), the adipose fin is well developed, and a large spine is situated on the shoulder girdle in front of the base of the pectoral. The local species reach a length of 150 to 170 mm.

As the two local species of this genus of the opposite slopes of the Canal Zone are well differentiated in color, these fishes apparently would be favorable ones to show cross-breeding if it had taken place in the Canal. However, as stated subsequently, no evidence was found indicating that intermingling or crossing over has taken place.

Roeboides guatemalensis (Günther).

Anacyrtus (*Roeboides*) *guatemalensis* Günther, Cat. Fish. Brit. Mus., **5**, p. 347, 1864—Rio Chagres, etc.

Roeboides guatemalensis Meek and Hildebrand, Field Mus. Nat. Hist., Zool. Ser., **10**, p. 291, 1916.

Numerous specimens were taken in Gatun Lake. The species was secured in 1935 and 1937, also, in an abandoned reservoir at Mount Hope, and in a creek tributary to Gatun Lake on Madden Dam Road. It is very common on the Atlantic slope of Panama, as stated by us (1916, p. 292), and its range extends northward into southern Mexico. Behre (1928, p. 318) recorded it from the Rio Chiriquí del Tire near Caldera, Pacific slope, with the remark: "These fishes (24 specimens) have hitherto been described from the Caribbean coast. We found them only on the Pacific slope."

The specific differences between this species and its relative, *occidentalis*, are shown in a key by Meek and Hildebrand (1916, p. 291). The most readily available recognition mark is the difference in color. *R. occidentalis* has a large black spot on the side about an eye's diameter behind a rather obscure shoulder spot present in both species. The second black spot is missing in *guatemalensis*. How-

ever, this species generally has a black streak, variable in length, within the silvery lateral band, which *occidentalis* does not have.

The many specimens at hand from Gatun Lake, taken chiefly at Barro Colorado Island and in the upper end of the lake toward Madden Dam, have been carefully compared with an equally large number of specimens of the genus from the Rio Cocoli and Miraflores Lake. Absolutely no indication of intermingling or cross-breeding was found, as the Gatun Lake specimens are typical *guatemalensis* and those from Miraflores Lake and the Rio Cocoli are typical *occidentalis*. Therefore, no evidence that these species have passed through the Pedro Miguel Locks was obtained.

The range of this species has been given as extending from southern Mexico to the Rio Chagres in Panama. Behre (1928, p. 318) reported it from the Pacific slope of western Panama, but did not get it on the Atlantic side. Meek (1914, p. 109) reported it from both slopes of Costa Rica. However, specimens from Liberia, Pacific slope of Costa Rica, studied by me (1930, p. 2) were *R. salvadoris*, a species readily separable from *R. guatemalensis* by the color, as it has no black in the silvery lateral band, but has a black spot on the side anteriorly, like *R. occidentalis*, except that the spot is much smaller. Evidently further study, and comparisons of specimens, are necessary to determine the exact distribution.

Roeboides occidentalis Meek and Hildebrand.

Roeboides occidentalis Meek and Hildebrand, Field Mus. Nat. Hist., Zool. Ser., **10**, p. 293, pl. 23, 1916.

In addition to numerous individuals taken in the Rio Cocoli and Miraflores Lake in 1935 and 1937, one specimen, 85 mm. long, was taken in the upper chamber of Miraflores Locks (west side). Numerous specimens, also, were seined in swamps at the La Jagua Hunting Club, and a few in the Rio Pacorá.

The differences in color between this species and its common Atlantic congener are pointed out in the discussion under *guatemalensis*. Although minor structural differences exist, the differences in color constitute the most easily used field characters for distinguishing the species. In the illustration (retouched photograph) offered by Meek and Hildebrand (1916, pl. 23) the prominent black lateral spot is shown as half above and half below the lateral line. This position must be regarded as unusual, at least, as in the large series of specimens now at hand it at most extends slightly below the lateral line, but is more usually wholly above it.

No indication of intermingling of this species and *guatemalensis* through Pedro Miguel Locks is evident. Indeed, neither species was obtained in these locks when they were dewatered in 1937, though one specimen of *occidentalis* was found in the upper chamber of Miraflores Locks. No evidence was secured indicating that the species has passed through these lower locks to brackish and salt water, which it normally does not inhabit.

Breder (1927, p. 126) reported this species as "Not common, but taken in all the larger streams except the Rio Chico and Tupisa" in the Chucunaque Basin. It is known only from the Pacific slope of central and eastern Panama. On the Pacific slope of Colombia, and probably Ecuador, according to Eigenmann (1922, p. 162), it is replaced by *R. hildebrandi;* and if Dr. Behre's identification (1928, p. 318) is correct it is replaced by *R. guatemalensis* (of the Atlantic slope) on the Pacific side in western Panama.

Brycon Müller and Troschel. SÁBALO PIPON.

The common name of all the species of this genus among the natives of Panama seems to be "sábalo pipon," meaning an *obese herring*. These fishes reach a moderately large size, examples upward of 2 feet (60 cm.) in length, at least of *B. chagrensis*, having been seen. They are valued as food, though quite bony. Although their teeth are relatively large and numerous, suggesting an animal diet, the alimentary canal is rather long, as in herbivorous fishes. Stomach contents show that the diet is a mixed one, consisting of both animal and plant remains. It is noteworthy that these fishes may be caught either with meat bait or with banana and perhaps other vegetable baits.

The collections made by Dr. Behre in western Panama in 1923, and the recent ones (1935 and 1937) by the writer in central Panama and westward to El Valle, contain three species of *Brycon* not included in our earlier work (1916), two of which apparently are new. A new key including the species added to the fauna of Panama is introduced.

The close relationship of the new species described from the Pacific slope (see p. 222), west of the Canal Zone, with species occurring in the Chagres Basin suggests a recent "crossing over" from the Atlantic to the Pacific slope. Both *striatulus* and *argenteus* of the Pacific watershed of central Panama are apparently replaced on the Pacific slope of western Panama by near relatives of *chagrensis* and *petrosus* of the Chagres Basin.

KEY TO SPECIES OF BRYCON

a. Scales small, 64 to 83 between upper angle of gill opening and base of caudal; anal fin much longer than head, with 30 to 37 rays.

b. Mandibular teeth very large and strong, usually 8 (rarely 7 or 9) in outer series; maxillary teeth very small and few, only 9 or 10 present; premaxillary teeth small, 12 to 14 in outer series; scales moderately large, 64 to 73, usually fewer than 70, 18 to 21 rows crossing back between dorsal and adipose .... *striatulus*.

bb. Mandibular teeth rather smaller and more numerous, usually more than 10 in outer series; premaxillary teeth larger and more numerous, 15 or more in outer series.

c. Pectoral long, frequently reaching nearly or entirely to base of ventral, seldom falling short of this point by more than 2 rows of scales, 4.1 to 5 in standard length; scales rather small and in more or less irregular series, 68 to 83 (usually more than 70) between upper angle of gill opening and base of caudal; teeth rather small, 14 to 20 in outer series on mandible, 10 to 13 on maxillary, and 15 to 18 in outer series on premaxillaries; second suborbital narrow, with rounded lower anterior angle .... *chagrensis*.

cc. Pectoral shorter, generally failing to reach base of ventral by 3 to 6 scales, 5.2 to 5.8 in standard length; scales somewhat larger and in more regular series, 66 to 79 between upper angle of gill opening and base of caudal; teeth somewhat larger, 10 to 14 (rarely 16) in outer series on mandible, 12 to 15 on maxillary, and 17 to 20 in outer series on premaxillaries; second suborbital broad, its lower anterior angle less rounded .... *behreae* sp. nov.

aa. Scales larger, 43 to 58 between upper angle of gill opening and base of caudal; anal fin little if any longer than head, except in *guatemalensis*.

d. Anal fin notably longer than head, with 32 to 38 rays; scales moderately small, 50 to 56 between upper angle of gill opening and base of caudal, 10 rows between lateral line and origin of dorsal, 4 or 5 between lateral line and base of ventral .... *guatemalensis*.

dd. Anal fin about equal to length of head, with 24 to 28 rays.

e. Scales moderately small, 48 to 58 between upper angle of gill opening and base of caudal, 7 to 10 rows between lateral line and origin of dorsal, 3 or 4 between lateral line and base of ventral, and 15 to 18 series crossing back between dorsal and adipose.

f. Pectoral long, reaching nearly or fully to base of ventral in small specimens, proportionately shorter in adult, about 1.2 in head; snout strongly projecting, 2 rows of teeth exposed in advance of lower jaw; teeth rather large, 8 to 10 enlarged ones in outer series on mandible, 12 to 14 in outer series on premaxillaries; scales rather small, 53 to 58 between upper angle of gill opening and base of caudal; sides with more or less definite dark cross bars or reticulations formed by black margins on the scales .... *petrosus*.

ff. Pectoral rather shorter, failing to reach ventral in small specimens by 2 or 3 rows of scales, about 1.4 in head; snout projecting less strongly, leaving only one row of premaxillary teeth exposed in advance of lower jaw; teeth smaller, though apparently equal in number; scales somewhat larger, about 48 to 55; sides plain silvery .... *obscurus* sp. nov.

ee. Scales larger, 43 to 48 between upper angle of gill opening and base of caudal, 7 or 8 rows between lateral line and origin of dorsal, 3 between lateral line and base of ventral, and 11 to 14 series crossing back between dorsal and adipose; snout projecting very little, with lower jaw reaching outer row of premaxillary teeth .... *argenteus*.

Brycon striatulus (Kner).

Chalcinopsis striatulus Kner, Sitzber. Bayer. Akad. Wiss., München, p. 226, 1863—Panama.

Brycon striatulus Meek and Hildebrand, Field Mus. Nat. Hist., Zool. Ser., **10**, p. 294, 1916.

No specimens of this species were secured during the recent investigations. A discussion of its relationship with *chagrensis* is included in the account of that species.

Since the publication of our earlier work, Breder (1927, p. 119) recorded this fish from several localities in the Chucunaque Basin, and Behre (1928, p. 317) listed *B. striatulus* from an upper tributary of the Rio Chiriquí on the Pacific slope of far western Panama. However, the specimens so listed by Dr. Behre are apparently representatives of a new species herein named *B. behreae*.

The species has been taken only from streams on the Pacific slope of central and eastern Panama, from the Rio Chorrera to the Rio Tuyra.

Brycon chagrensis (Kner).

Chalcinopsis chagrensis Kner, Sitzber. Bayer. Akad. Wiss. München, p. 223, 1863—Rio Chagres.

Brycon chagrensis Meek and Hildebrand, Field Mus. Nat. Hist., Zool. Ser., **10**, p. 295, 1916.

Many specimens were taken in the upper part of Gatun Lake, that is, between Gamboa and Madden Dam. Additional specimens were taken in Miraflores Lake and the Rio Cocoli, tributary to Miraflores Lake, and one in Pedro Miguel Locks.

B. chagrensis is an Atlantic slope species, heretofore definitely recorded only from the Rio Chagres Basin. To reach Miraflores Lake and the Rio Cocoli the fish had to pass through Culebra Cut and Pedro Miguel Locks.

The closest Pacific slope congener, *B. striatulus*, which is known from the Tuyra, Bayano, Juan Diaz, and Chorrera rivers, was not taken in the Rio Grande system (the main stream having been destroyed during the construction of the Panama Canal) in 1911 and 1912, before the opening of the Canal, when rather thorough collecting was carried out in its then largely undisturbed tributaries. Nor was it ever recorded from this river basin. As it does not appear in the recent collections, and as the specimens of *chagrensis* (and *petrosus*) seem quite typical, showing no signs of cross-breeding, it may perhaps be assumed that *striatulus* does not occur in the Rio Grande Basin.

B. chagrensis has been synonymized with *B. striatulus* (Kner) by various authors (Regan, 1908, p. 169: Behre, 1928, p. 317; Jordan, Evermann and Clark, 1928 [1930], p. 98). This treatment has led to a careful recheck of the species of *Brycon* from the opposite slopes of Panama.

There can be no reasonable doubt about the specific distinctness of the specimens from the Atlantic and Pacific drainages of eastern Panama. The differences were mostly correctly indicated long ago by Kner and Steindachner (Abhandl. Bayer. Akad. Wiss. München, **10**, 1866, pp. 38 to 43, pl. 5, figs. 2 and 3), who made the mistake, however, of stating that *striatulus* has 8 to 10 mandibular teeth in the outer series *"an jederseits"* and *chagrensis* 14. "On each side" is clearly a mistake, for the species do not have as many teeth as twice the number given, as shown by the excellent illustrations offered. The number given is plainly the total number of enlarged mandibular teeth, which are followed on each side by about 2 or 3 smaller ones.

The differences between *B. striatulus* and *chagrensis* were stated in greater detail by Meek and Hildebrand (1916, pp. 293 to 299), who pointed out a difference also in the size and number of maxillary teeth, those of *striatulus* being small, and only 9 or 10 in number, whereas those of *chagrensis* are larger and more numerous, each maxillary being provided with 12 or 13 teeth. These data have been rechecked with specimens and found to be correct. It may be added that a similar difference in size and number in the outer series of premaxillary teeth exists, *striatulus* having 12 to 14 rather small teeth and *chagrensis* 16 to 18 somewhat larger ones.

Kner and Steindachner pointed out that *striatulus* has larger scales than *chagrensis*. This difference is only an average, instead of an absolute one, as already shown by Meek and Hildebrand. The overlapping is due in part to a rather large variation in the actual number of series of scales present, and also in part no doubt to errors and to differences in place of enumeration. The scales are small and the series not always very regular, making them difficult to count accurately, especially in small specimens. The writer has enumerated the lateral series of scales of one specimen several times and obtained results that differed by as much as 5 scales. Furthermore, it makes a difference whether the series is counted along the upper part of the side from the upper anterior angle of the gill opening to the base of the caudal, or lower down, along the lateral line between the margin of the opercle and the base of the caudal where the scales

are larger. If the series is taken along the upper part of the side, between the upper angle of gill opening and the base of the caudal, the range for *striatulus* may stand as 64 to 73, and for *chagrensis* as 70 to 83. Generally *striatulus* has fewer than 70 and *chagrensis* more than 70 oblique series of scales on that part of the side.

There is so little difference in the color patterns of the two species that they cannot be separated on that basis, although large specimens of *striatulus* often lack the blackish crossbars or reticulations which are always retained in life by *chagrensis*, so far as can be determined from the material at hand.

This species remains known only from the Chagres Basin.

Brycon behreae sp. nov.

Brycon striatulus Behre (not Kner), Ann. Carnegie Mus., 18, p. 317, 1928.

Type from Rio Chiriquí del Tire, above Caldera, Pacific slope, western Panama. No. 5582 California Academy of Sciences. Total length 330 mm., standard length 265 mm.

Description of the type.—Head 4.75; depth about 3.2; D. 11; A. 32, including undivided rays; scales 68.

Body rather robust; caudal peduncle slender, its depth 2.5 in head; head short, deep; snout rather short, conical, 3.2 in head; eye 4.5; second suborbital broad, leaving little of the cheek exposed, its lower anterior angle nearly a right angle, its depth at vertical of posterior margin of pupil 5 in head; mouth moderate, maxillary reaching opposite middle of eye; lower jaw shorter than upper, leaving 2 rows of teeth exposed in advance of it; teeth large, the premaxillary ones laterally in 2 series, anteriorly more or less definitely in 4 series, the outer series with a total of 17 teeth, each maxillary with 15 teeth, mandible with a total of 15 teeth; gill rakers slender, scarcely as long as pupil, 16 on lower limb of first arch; lateral line complete, decurved anteriorly; scales firm, with very prominent striae, in regular series on sides, 24 rows crossing back before dorsal, 19 between dorsal and adipose, 14 rows between lateral line and origin of dorsal, and 7 rows between lateral line and base of ventral; dorsal with straight margin, its origin equidistant from snout and base of caudal; caudal broadly forked, the lower lobe about an eye's diameter longer than the upper one; anal fin elevated anteriorly, the last 12 or 13 rays of about equal length, its origin a little posterior to vertical from end of base of dorsal; ventrals failing to reach vent by 5 rows of scales; pectorals short, failing to reach ventrals by 6 rows of scales, 5.7 in standard length.

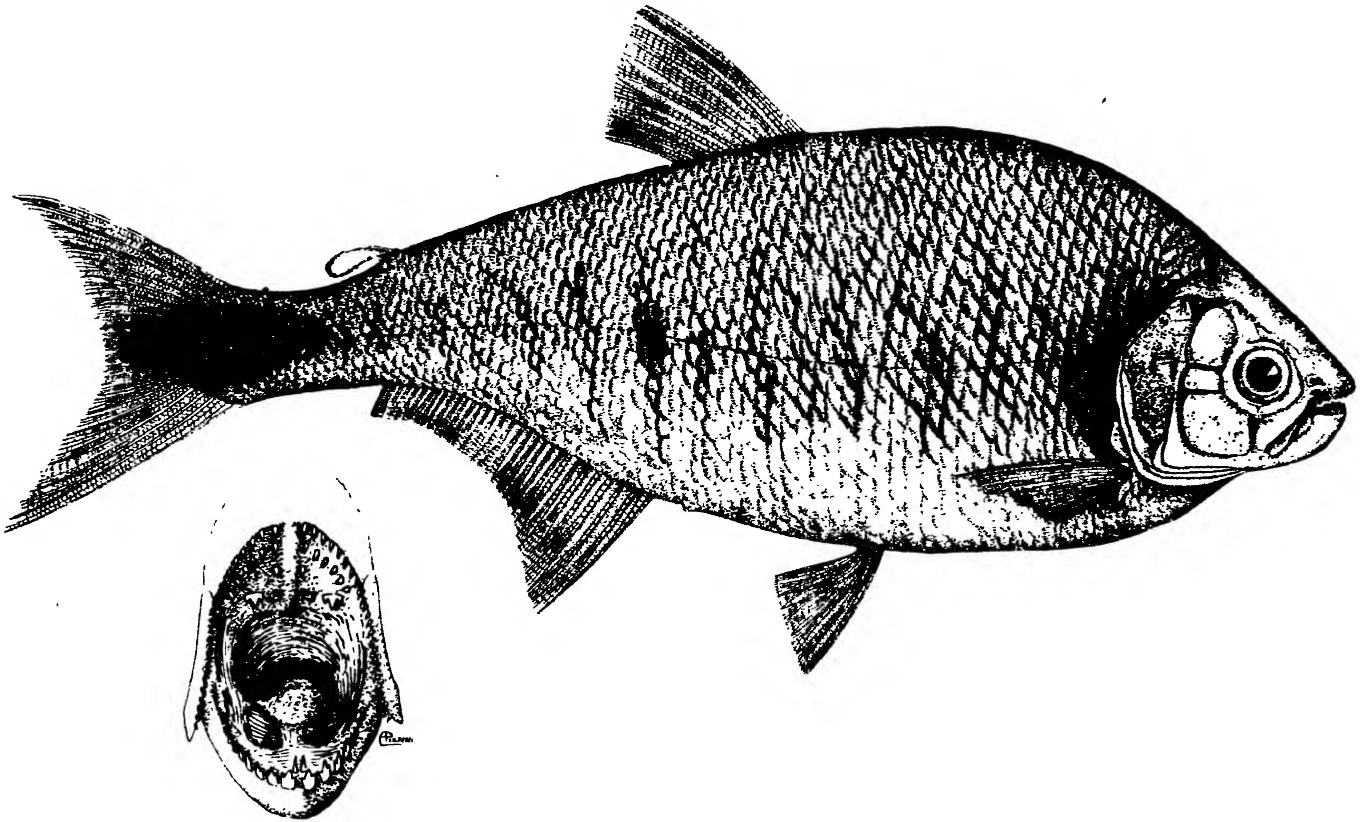

FIG. 5. *Brycon behreae* sp. nov. Type, 330 mm. long. (From drawing by Mrs. Alice C. Mullen.) Insert: open mouth of same specimen, showing arrangement of teeth.

Color bluish silvery above, pale below; a black vertical band under and behind opercular margin, middle of sides with rather prominent black bars; a black blotch at base of caudal; ventrals pale; all the other fins more or less dusky, at least on membranes.

This species is based on specimens collected in the Rio Chiriquí del Tire and tributaries, Rio Chiriquí Basin, Pacific slope of western Panama, in the general vicinity of Caldera, by Dr. Ellinor H. Behre, for whom I am pleased to name the species. This material is now mostly in the museum of the California Academy of Sciences and the Carnegie Museum. Through the kindness of H. Walton Clark of the first mentioned institution, and Arthur W. Henn of the latter, I have been able to compare 31 specimens of Dr. Behre's collection with many specimens from central and eastern Panama.

The specimens from the Pacific slope of western Panama (*behreae*) were identified as *Brycon striatulus* by Dr. Behre, who regarded *B. chagrensis* as a synonym of *striatulus*. However, well-marked characters distinguish the two, as shown in our earlier work (1916), and restated with some additions in this paper in the account of *B. chagrensis*. *B. striatulus* is not represented among Dr. Behre's specimens from the Pacific slope of western Panama examined by me. The specimens are so closely related to *chagrensis*, however, that they seem scarcely specifically distinct. Some differences have been noticed, as shown subsequently.

It is very interesting to find *striatulus* apparently replaced by a very close relative of *chagrensis* on the Pacific slope of western Panama. It is of interest, furthermore, that Dr. Behre (1928, p. 318) did not find *chagrensis* in the streams of the Atlantic slope of western Panama, but reported instead *B. guatemalensis*. To date, then, *B. chagrensis* remains known only from the Chagres Basin.

The specimens from the Pacific slope of western Panama (*behreae*) vary more prominently among themselves than Chagres River specimens (*chagrensis*). Because of the great variations some of the specimens differ rather strikingly from those of the Chagres, but others are distinguished with difficulty, and still others are intermediate. The most constant character in which the specimens from western Panama differ is the shorter pectoral fin, as shown by the proportional measurements given subsequently. The average number of scales in a lateral series also is a little lower; the teeth, though usually agreeing in number are larger; often the snout projects less prominently, though that is a very variable character among specimens from western Panama, as in some specimens only a

single row of premaxillary teeth is exposed whereas in others as many as three rows are in advance of the lower jaw; the body in the larger specimens seems to be rather more robust, but accurate measurements cannot be made as the specimens have been eviscerated, the smaller specimens are quite as slender as those from the Chagres River; and the second suborbital is generally broader with a sharper lower anterior angle, leaving less of the cheek exposed. The color of preserved specimens is nearly identical, the dark bars on the sides of large specimens being a little more prominent on the western Panama material.

The following counts and proportions are based on 21 specimens collected in the Rio Chiriquí Basin, western Panama, and on 22 specimens from the Rio Chagres Basin. Counts and proportions of the latter are placed in parentheses: Head 3.5 to 4.7 (4 to 4.8); depth 3 to 3.7 (3.2 to 3.5); D. 10 or 11 (11); A. 32 to 35 (30 to 36); scales 66 to 79, average 71 (68 to 83, average 74.5); rows of scales crossing back in front of dorsal fin 20 to 27, average 24.4 (25 to 30, average 26.4); rows of scales crossing back between dorsal and adipose 16 to 22, average 20 (18 to 25, average 21.1). Snout 3.4 to 4.1 (3.5 to 3.8) in head; eye 3.2 to 3.8 (3.4 to 4.1); pectoral 1.2 to 1.35 (1 to 1.2) in head, or 5.2 to 5.8 (4.1 to 5) in standard length. Teeth in outer row on premaxillary 17 to 20 (15 to 18); teeth on maxillary 12 to 15 (10 to 13); teeth in outer series on mandible 10 to 16, average 13 (14 to 20, average 16.7).

Brycon guatemalensis Regan.

Brycon guatemalensis Regan, Biol. Cent. Amer., Pisces, p. 168, 1907—Guatemala, Atlantic drainage; Behre, Ann. Carnegie Mus., 18, p. 318, 1928.

This species is included in the list of Panama fishes on the basis of a record by Behre (1928, p. 318), who recorded it from the Rio Guarumo and the Rio Cricamola, both emptying into the Chiriquí Lagoon, Atlantic slope of western Panama.

I have not seen Dr. Behre's specimens, but have examined 8 specimens of *guatemalensis* in the National Museum, from Guatemala and Nicaragua. The species is readily recognized by the long anal fin, which is longer than the head and has 32 to 38 rays (including simple rays), and by a moderate number of scales, there being 50 to 56 oblique series along middle of side between the upper angle of gill opening and base of caudal, 9 or 10 longitudinal rows between the lateral line and origin of dorsal, and 4 or 5 rows between the lateral line and base of ventral. This combination of anal fin ray and scale counts is found in no other species of the genus known from Panama.

The teeth are rather small and numerous; premaxillaries with 16 or 17 in the outer series, maxillary with 16 or 17, and mandible with 10 large ones, followed on each side by 2 or 3 smaller ones, in the outer row. The relationship of this species to *argenteus*, a rather near relative, is discussed in the account of the last-named species.

As here understood, this species ranges on the Atlantic slope from Guatemala to Western Panama.

Brycon petrosus Meek and Hildebrand.

Brycon petrosus Meek and Hildebrand, Field Mus. Nat. Hist., Zool. Ser., **10**, p. 184, 1913-- upper Chagres; and p. 297, pl. 24, 1916.

Small specimens were taken in the Rio Boquerón, in current at the edge of Madden Lake; in a rocky creek, tributary to Gatun Lake, near Madden Dam; and in the Rio Cocoli. *B. petrosus* was previously recorded only from the Chagres Basin. It no doubt reached the Rio Cocoli by passing from Gatun Lake through Culebra Cut, the Pedro Miguel Locks, and Miraflores Lake.

A close relative is its Pacific slope congener, *B. argenteus*. Though that species is recorded from streams both east and west of the Panama Canal, namely, from the Tuyra, Bayano and Chorrera rivers, it has not been found in the Rio Grande drainage. Since fairly thorough collecting has been done it may be assumed that the species does not occur in such parts of this river system as remain, because the main stream was destroyed in the construction of the Canal.

B. argenteus differs from *petrosus* chiefly in having larger scales. The first named has from 43 to 48 oblique series of scales on the side between the upper angle of the gill opening and the base of the caudal; 7 or 8 longitudinal rows between the lateral line and origin of dorsal; 3 between the lateral line and base of ventral; and 11 to 14 series crossing the back between the dorsal and adipose. *B. petrosus*, on the other hand, has 53 to 58 scales along the side, counted in the same way; 9 or 10 rows between the lateral line and origin of dorsal; 3 or 4 between the lateral line and base of ventral; and 15 to 18 series between dorsal and adipose.

Brycon argenteus and *petrosus* both differ from *striatulus* and *chagrensis* in having larger scales, the combined range being 43 to 58 in lateral series in the first two and 64 to 80 in the last two. Also, the anal fin is shorter in *argenteus* and *petrosus* which have a combined range of 24 to 28 rays, including the simple ones, whereas *striatulus* and *chagrensis* have 30 to 37 rays.

The close relationship of this species to *B. obscurus* sp. nov. is pointed out in the discussion of that species.

Brycon obscurus sp. nov.

Type from a creek in El Valle, Pacific slope, Panama. No. 106512 United States National Museum. Total length 96 mm., standard length 77 mm.

Head 3.7; depth 3.5; D. 10; A. 28, including undivided rays; scales 55. Body elongate, compressed; dorsal profile rather more strongly curved than the ventral; snout moderately pointed, 3.8 in head; eye 3.5; interorbital 3.35; lower jaw moderately long with a broad lip about three-fourths diameter of pupil, covering second series of premaxillary teeth; maxillary not quite reaching middle

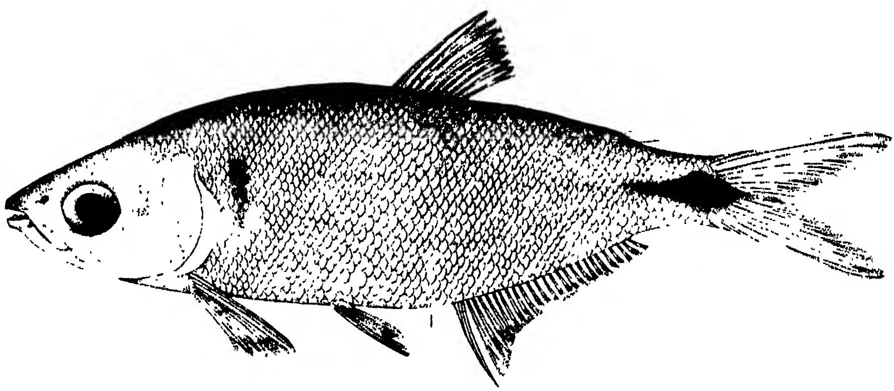

FIG. 6. *Brycon obscurus* sp. nov. Type, 96 mm. long. (From drawing by Andrew Pizzini.)

of eye, 2.3 in head; premaxillary teeth anteriorly in 3, and laterally in 2 series, a total of 14 small tricuspids in the outer series; about 12 very small ones on maxillary; teeth in lower jaw large, anteriorly 8 large ones with 3 to 5 cusps, followed on each side by 1 or 2 smaller teeth (teeth on right side of lower jaw abnormal, apparently having been broken, being without cusps); gill rakers scarcely more than half the diameter of pupil, 14 on lower limb of first arch; lateral line strongly decurved; scales moderately small, 10 rows between lateral line and base of dorsal, 4 between lateral line and base of ventral, 15 rows crossing back between dorsal and adipose; dorsal with very slightly concave margin, the longest anterior rays reaching somewhat beyond the posterior ones if deflexed, its origin about midway between base of ventrals and origin of anal, equidistant from anterior

margin of eye and base of caudal; caudal deeply forked; anal fin moderately long, its base equal to head, the origin just behind base of dorsal; ventral fins reaching vent; pectorals failing to reach ventrals by 2 or 3 rows of scales, 1.4 in head.

Color mostly plain silvery; back bluish; a short dark vertical bar at shoulder; no other dark cross-markings; a dusky blotch on opercle; base of caudal with a prominent elongate black spot. No lateral band; posterior half of body with a horizontal line along middle of side. Fins unmarked, except for dusky chromatophores.

In addition to the type, 5 paratypes, ranging in length from 42 to 52 mm., are at hand. These small specimens are more slender than the larger one, as usual in this genus, the depth being contained 3.6 to 3.8 times in the standard length. The scales are rather difficult to count. However, the range seems to be 48 to 54, with 10 or 11 complete rows between the lateral line and base of dorsal, and 4 between the lateral line and base of ventral. Eight enlarged teeth in the lower jaw are constantly present. The range in the number of anal rays is 25 to 28, including the simple ones. The small specimens are less silvery than the type, and have an obscure dusky lateral band. In other respects they are similar to the type in color.

This species is close to *petrosus*, a species indigenous to the upland streams in the Rio Chagres Basin. More and larger specimens are required to determine the exact relationship. However, the El Valle specimens appear to be more slender. This difference is evident only if specimens about equal in size are compared, as the species of this genus tend to become deeper with age. The eye, also, has the appearance of being smaller, and the snout projects less strongly beyond the lower jaw, the second series of premaxillary teeth being well in advance of lower lip in *petrosus*, whereas in the present species the lower lip almost if not quite covers the second series. The lower lip in the El Valle specimens seems to be broader and thicker, being fully three-fourths the width of pupil, whereas in *petrosus* it is scarcely half as wide as pupil. The teeth, especially the maxillary and premaxillary ones, are rather smaller in the El Valle specimens, though the average number may be equal. The pectoral and ventral fins have the appearance of being rather shorter, failing by 2 or 3 rows of scales to reach, respectively, the base of the ventrals and the origin of the anal, whereas in young *petrosus* these fins usually reach the points named. Finally, the species differ in color. The El Valle specimens are plain silvery on sides, none of the scales having dark

margins, whereas in young *petrosus* many scales have dark margins, tending to form blackish reticulations or crossbars.

If more and larger specimens come to hand, other and more distinctive characters may become evident. Though the relationship with *petrosus* of the Chagres River (Atlantic drainage) is close, it seems improbable that the El Valle specimens (Pacific drainage) will prove to be identical. It is interesting, however, that the relationship of *petrosus* is nearer to the El Valle specimens than to *argenteus*, occurring in the Chorrera and Bayano rivers, immediately opposite the Chagres. To date no identical specimens from the opposite slopes of eastern Panama have been found among many specimens examined by the writer. Recently (1935 and 1937) the writer took both *B. chagrensis* and *B. petrosus* in the Rio Cocoli, now tributary to Miraflores Lake, and *chagrensis* in Miraflores Lake. However, these waters are accessible to the fishes from the Chagres River (or Gatun Lake) by passing through Culebra Cut and Pedro Miguel Locks.

The El Valle specimens differ from *argenteus*, a species of the streams of the Pacific slope of eastern Panama, principally in having notably smaller scales. *B. argenteus* has about 43 to 48 oblique series of scales on middle of side between the margin of the opercle and base of caudal, 7 or 8 complete longitudinal rows between the lateral line and origin of dorsal, and only 3 between the lateral line and base of ventral.

Brycon argenteus Meek and Hildebrand.

Brycon argenteus Meek and Hildebrand, Field Mus. Nat. Hist., Zool. Ser., **10**, p. 84, 1913—Rio Aruza, tributary of the Tuyra; ibid., p. 298, pl. 25, 1916.

This species was not among the recent collections. It is not recorded from the Canal Zone, though it has been taken in Pacific slope streams east and west of the Canal Zone, as pointed out in the discussion of *B. petrosus*, its nearest relative. A discussion of the relationship of this species is introduced here because its validity has been questioned, which led the writer to make a further study of its relationship with other species of the genus. The results of this further study, principally of specimens, are included partly in the account of *B. petrosus* and partly in the following paragraphs.

The question of the identity of this species with *B. guatemalensis*, a Central American species presumably only of the Atlantic slope, was brought up by Behre (1928, p. 318), who quotes Eigenmann: "It seems very probable that *B. argenteus* is identical with this species." I have not seen Dr. Behre's specimens, which are from the

Atlantic drainage of western Panama, but I have examined eight specimens from Guatemala and Nicaragua in the National Museum. According to Regan's original description (1908, p. 168) the specimens examined apparently are all *guatemalensis* and certainly all specifically distinct from *argenteus*.

The Central American specimens differ at once in the longer anal, which is composed of 32 to 38 rays, and its base is much longer than the head, whereas *argenteus* has only 24 to 28 anal rays, and the base of the fin does not exceed the length of the head. Furthermore, *guatemalensis* has smaller scales, there being 50 to 56 in the lateral series, 9 or 10 longitudinal rows between the lateral line and origin of dorsal, and 4 or 5 between the lateral line and base of ventral, whereas *argenteus* has 43 to 48 scales in the lateral series, 7 to 9 rows between the lateral line and origin of dorsal, and 3 or 4 between the lateral line and base of ventral. Finally, *guatemalensis* seems to have smaller and more numerous teeth, the outer series in the premaxillary consisting of 16 teeth, and the outer series of mandibular teeth consisting of 10 enlarged ones followed at each side by 2 or 3 smaller ones. *B. argenteus* has 14 teeth in the outer premaxillary series, and 8 enlarged mandibular teeth.

The relationship of this species with *B. obscurus* sp. nov. is pointed out in the account of that species.

This fish is known from the Pacific slope of Panama from the Rio Chorrera to the Rio Tuyra, but not from the Canal Zone.

Piabucina Cuvier and Valenciennes.

The fishes of this genus have an elongate body, which is somewhat compressed; the teeth in the premaxillaries are in one series, and those on the mandible are in two well-separated series; all or nearly all are tricuspid; the scales are large and firm (27 to 30 in a lateral series in Panama species); the lateral line is missing; the dorsal and anal fins are short (the former with 8 to 10 rays, and the latter with 10 to 12 in Panama species); and an adipose fin is present.

Two closely related species have been recognized from Panama, namely *panamensis* and *festae*, the latter only from the Tuyra Basin. The species apparently differ chiefly in color. Both have a dark lateral band, but the one in *panamensis* originates above the posterior (distal) angle of the opercle, is situated on the middle of the side, and is often broken up into dark spots, whereas in *festae* this band begins at the posterior (distal) angle of the opercle, is below the middle of the side, is continuous (not broken up into separate spots),

and does not end in a caudal spot as in *panamensis*. In *festae* a separate dark shoulder spot is present, which is connected with the lateral band in *panamensis*.

Piabucina panamensis Gill. "DOMINI CANDELA."

Piabucina panamensis Gill, Proc. Acad. Nat. Sci. Phila., p. 336, 1876—Rio Frijoles, Canal Zone; Meek and Hildebrand, Field Mus. Nat. Hist., Zool. Ser., **10**, p. 300, 1916.

The principal recognition marks of this characin have already been set forth in the account under the generic name. Its usual habitat is in streams among rocks where it is easily recognized by a bright yellow, generally elongate, spot in advance of the dorsal fin. This spot is much more distinct in the water than in a fish just removed from the water, and it fades completely shortly after death. In shape, behavior, and habitat this fish resembles the brook trout somewhat. It is a rapid swimmer, darting here and there quickly for cover. As it is quick in its movements and generally stays in rocky places it is difficult to net. However, it takes the hook readily, but a wire leader is necessary, as it is able to snap a line easily with its comparatively large sharp teeth. It apparently rarely exceeds a length of 200 mm., and therefore is too small to be of much value as food.

Its resemblance to the trout apparently has given origin to the belief (or supposition) among some Canal Zone employees that it actually is a trout, presumably introduced by the French at the time a company of Frenchmen attempted to construct an Isthmian canal. The bright yellow spot in advance of the dorsal fin, as seen in the water, appearing more or less as a light, apparently had something to do with the origin of the local name "domini candela."

During the breeding season, at least, adult males may be distinguished from the females by a thickening of the tissues surrounding the anterior simple rays of the anal. Ripe or nearly ripe fish were taken during February.

This fish evidently feeds on both animal and plant foods. A large seed, some leaves of an unidentified plant, and vegetable debris were found in the several stomachs examined. The same fish had fed also on insects, and one had ingested a small shrimp.

This species was secured during the recent investigations in the Atlantic drainage at Cativa, Fort Sherman (Toro Point), and in a small stream on Barro Colorado Island. On the Pacific side it was collected in the Rio Cocoli (flowing into Miraflores Lake) and in the

Rio Capira near Campaña. As this fish seems to confine itself to rocky streams it probably never enters the Canal.

Eigenmann (1922, p. 126) gave as the habitat of this species, "Panama on both slopes, Atrato Basin, and San Juan Basin." If this is the correct distribution it seems singular that the species has not been taken in the Tuyra Basin, where numerous specimens of *P. festae* have been collected.

Piabucina festae Boulenger.

Piabucina festae Boulenger, Boll. Mus. Torino, No. 346, **14**, p. 1, 1899—Laguna de la Pita, Darien, Panama; Meek and Hildebrand, Field Mus. Nat. Hist., Zool. Ser., **10**, p. 301, 1916.

Since 1916 this species has been reported from the Rio Chucunaque by Breder (1927, p. 117), who had 40 specimens ranging in length from 54 to 130 mm. Mr. Breder stated: "There is a distinct dark spot near the bases of the fourth, fifth, and sixth dorsal rays, the fifth passing through its center, which is not mentioned in descriptions."

This species, as now understood, is known only from the Rio Tuyra Basin. In our earlier work (1916, p. 301) we gave as habitat, "Rio Tuyra Basin and southward to Colombia," believing at that time that at least the Atrato specimens were identical with those from the Tuyra. However, Eigenmann (1922, p. 126) included the specimens from the Atrato and San Juan rivers under *P. panamensis*.

Ctenolucius Gill.

Ctenolucius Gill, Senate Doc. 9, Second Sess., thirty-sixth U. S. Congress, **7**, pt. 1, 1861, p. 258 (name only); Proc. Acad. Nat. Sci. Phila., **13**, Suppl., p. 8, 1861.

The name *Ctenolucius* supersedes *Luciocharax*, used by us (1916, p. 302), because of the law of priority. Gill did not name a type for *Ctenolucius*, but Jordan sets forth the case in his "The Genera of Fishes" (pt. III, 1919, p. 302) as follows, "*Ctenolucius* Gill, 8; orthotype not named = *Luciocharax insculptus* Steind. It is described as an ally of *Xiphostoma*, a South American Characin, identical with *Luciocharax* Steind., 1876, which name it should replace." Eigenmann (1922, p. 166) accepted this decision, but questioned whether *Hydrocynus hujeta* (*Xiphostoma hujeta* Cuvier and Valenciennes, Hist. Nat. Poiss., **22** p. 358, 1848), recorded from Maracaibo, is not identical with *C. insculptus*.

The long, slender pike-like body, the produced, spike-like snout, and the firm pectinate scales readily distinguish the single species known from Panama from all the other local characins.

Ctenolucius beani (Fowler).

Belonocharax beani Fowler, Proc. Acad. Nat. Sci. Phila., p. 464, 1906—Rio Truando, tributary of the Rio Atrato.

Luciocharax beani Meek and Hildebrand, Field Mus. Nat. Hist., Zool. Ser., **10**, p. 302, 1916.

This species, which is the only one of the genus occurring in Panama, differs so greatly from all other fresh-water fishes, as already stated in the generic account, that it is readily recognized. It is known only from the Pacific slope in Panama from several streams east of the Canal Zone, but not from the Zone itself. During the recent investigations it was taken only in a swamp at the La Jagua Hunting Club.

A related species, *C. insculptus*, occurs in the Magdalena Basin, Atlantic slope of Colombia, differing principally in the absence of the dark stripes between the rows of scales along the sides. Generally the incomplete lateral line is present on fewer scales in that species than in *C. beani*, 17 to 28 scales having pores in the Magdalena fishes, whereas in the other species pores are present on 27 to 39 scales. The Panama fish seems to prefer standing or sluggish water. It reaches a maximum length of about 325 mm.

Breder (1927, p. 128) found *C. beani* abundant at several places in the Chucunaque Basin. In 78 stomachs examined he found only fish and decapod crustaceans, indicating that the fish are wholly carnivorous, as suggested by the very short intestinal canal.

This characin is recorded from the Pacific slope of central and eastern Panama to the San Juan River in Colombia, and from the Atrato Basin of the Atlantic slope in Colombia.

Hoplias Gill.

The elongate, scarcely compressed body; the rather large mouth with strong teeth, some of them canines; the short dorsal and anal fins (D. 13 to 15; A. 10 or 11); and the absence of an adipose fin characterize this genus.

Two closely related species are known from Panama, namely, *microlepis* and *malabaricus*. These usually differ in the number of rows of scales, the former having 11 rows across the caudal peduncle from the lateral line on one side to the one on the other, and 5 complete rows between the lateral line and the base of anal, whereas the latter has 9 rows across the peduncle and only 4 between the lateral line and the base of anal. Some evidence indicating that the two intergrade has been found (Breder, 1927, p. 129).

Hoplias microlepsis (Günther). PESCA PERRO; PEJEPERRO.

Macrodon microlepis Günther, Cat. Fish. Brit. Mus., **5**, p. 282, 1864—Rio Chagres and western Ecuador.

Hoplias microlepis Meek and Hildebrand, Field Mus. Nat. Hist., Zool. Ser., **10**, p. 303, 1916.

This species is easily distinguished from other Panama fishes exclusive of the closely related one occurring in the Tuyra Basin and southward, mention of which was made in the account under the generic name. The elongate, rather robust body, which is scarcely compressed; the large mouth with strong teeth; the short dorsal with only 13 or 14 rays, placed over the mid-length of the back; the short anal with only 10 or 11 rays; the absence of the adipose fin; and the general dark brown to smutty color above, serve to characterize the species. It is common in lowland streams and swamps on both slopes of Panama, west of the Tuyra Basin. It is commonly found in still shallow water among vegetation, where it seemingly hides waiting for its prey, as it no doubt is a highly predatory species. It has acquired its common names, namely, "pesca perro" and "pejeperro," from its large teeth and the habit of snapping dog-like at anything coming near. If care is not taken it will wound the hands severely when picked up after being caught in a net. The species reaches a length of about 46 to 50 cm., but it is not valued as food, being eaten sparingly.

It is very common on both slopes of central Panama, and according to Eigenmann (1922, p. 169) also on the Pacific slope of southern Ecuador. It is not reported from western Panama. During the recent investigations it was not secured in the Rio Cocoli nor Miraflores Lake, though it doubtless occurs there. It was taken at Barro Colorado Island; in the upper end of Gatun Lake near Madden Dam, and in a small creek near the same place. This species seems to be less numerous in the Gatun and Miraflores lakes areas than it was before the opening of the Canal. It was very abundant in the swamps near the La Jagua Hunting Club in 1935, when some rather large individuals were taken and offered to a native, who refused them, saying they were no good.

Hoplias malabaricus (Bloch).

Esox malabaricus Bloch, Naturgesch. der Ausland. Fische, pt. 8, p. 149, pl. 392, 1794.

Hoplias malabaricus Meek and Hildebrand, Field Mus. Nat. Hist., Zool. Ser., **10**, p. 305, 1916.

This species has been recorded from 15 specimens from the Chucunaque Basin by Breder (1927, p. 129) since the publication

of our earlier (1916) work. The relationship of this species and the preceding one is discussed in the account of the genus.

The range is given by Eigenmann (1922, p. 170) as extending from the Tuyra Basin in Panama south to the Patía (southern Colombia) on the Pacific slope, and from the Atrato Basin in Colombia to Buenos Aires on the Atlantic slope.

Family GYMNOTIDAE

Gymnotus carapo Linnaeus.

Gymnotus carapo Linnaeus, Syst. Nat., Ed. 10, **1**, p. 246, 1758; Meek and Hildebrand, Field Mus. Nat. Hist., Zool. Ser., **10**, p. 307, 1916.

An account of this species, not then known from Panama, was included in our earlier work (1916, p. 307) because it was recorded from both north and south of Panama. Behre (1928, p. 310) reported two specimens from a small stream flowing into Almirante Bay, Atlantic slope of extreme western Panama, which is the only record from Panama known to me.

The general range of this gymnotid eel extends from Guatemala (both slopes) to Colombia (both slopes) and southward east of the Andes to Rio de la Plata.

Sternopygus dariensis Meek and Hildebrand.

Sternopygus dariensis Meek and Hildebrand, Field Mus. Nat. Hist., Zool. Ser., **10**, p. 309, pl. 26, 1916.

This eel, first taken in the lower Tuyra (Meek and Hildebrand, 1916, p. 309) in a very muddy tidal creek, where it was numerous, was later reported from El Real de Santa María, still lower down on the Tuyra, and from two localities in the lower part of the Chucunaque Basin (Breder, 1927, p. 130). It was not seen during the recent investigation.

This species is known to date only from the material already mentioned from the lower part of the Tuyra and Chucunaque rivers.

Hypopomus brevirostris (Steindachner).

Rhamphichthys brevirostris Steindachner, Sitzber. Akad. Wiss. Wien, **58**, p. 254, pl. 2, fig. 2, 1868—Guaporé.

Hypopomus brevirostris Meek and Hildebrand, Field Mus. Nat. Hist., Zool. Ser., **10**, p. 310, 1916.

This species was reported in our earlier work (1916, p. 310) from two specimens from the Chagres Basin and two from the Bayano. Since that time Breder (1927, p. 130) has reported four specimens from the Chucunaque Basin, and Behre (1928, p. 309)

recorded 47 specimens from the Rio Cricamola, Atlantic slope of western Panama.

It occurs in rivers on both slopes of Panama and Colombia, and apparently east of the Andes to Paraguay.

Eigenmannia virescens (Valenciennes).

Sternarchus virescens Valenciennes, in d'Orbigny, Voy. Amér. Mérid., **5**, pt. 2, p. 11, pl. 13, fig. 2, 1847.

Eigenmannia virescens Meek and Hildebrand, Field Mus. Nat. Hist., Zool. Ser., **10**, p. 311, 1916.

This species is not in the recent collections. We secured only two specimens in 1911 and 1912. These were taken at Marrigante, in the Tuyra, below the head of tide water. It is reported also from the Rio Mamoni, near Chepo, by Steindachner (1879, p. 169) under the name *Sternopygus humboldtii*, a record overlooked by us when preparing our earlier work.

The range as now understood extends from the Rio Mamoni and the Rio Tuyra in Panama to the Rio Magdalena in Colombia and southward to Buenos Aires.

Sternarchus rostratus Meek and Hildebrand.

Sternarchus rostratus Meek and Hildebrand, Field Mus. Nat. Hist., Zool. Ser., **10**, p. 85, 1913 Rio Grande near Cana, Panama; p. 312, pl. 27, 1916.

This gymnotid eel is known from Panama only from the type, taken in the Rio Grande, an upper tributary of the Tuyra River. Eigenmann (1922, p. 176) recorded several specimens from the Rio Magdalena on the Atlantic slope of Colombia.

Family SYNBRANCHIDAE

Synbranchus[1] **marmoratus** Bloch.

Synbranchus marmoratus Bloch, Ichthyol., **9**, p. 87, pl. 418, 1795; Meek and Hildebrand, Field Mus. Nat. Hist., Zool. Ser., **15**, p. 131, 1923.

Six specimens are at hand, ranging in length from 93 to 345 mm. Five of these, all small, 93 to 120 mm. long, are from a lily pond at Summit, Canal Zone, where the species was reported numerous, and one is from an unknown number of miles west of Balboa. The largest specimen was presented by G. O. Lee, head of the department of biology of the junior college at Balboa, and the others were obtained through the interest and kindness of employees of the botanical station at Summit.

[1] Spelling has been corrected to *Symbranchus* by Eigenmann (1922, p. 177) and some other writers.

Breder (1927, p. 131) listed 12 specimens, eight from the Rio Sucubtí, tributary of the Chucunaque, three from the Rio Tapia, near Panama City, and one from Caledonia on the Atlantic. Mr. Breder stated that he always found this eel buried under sand or rocks, which explains why it is not taken in seines. He said, also, that calcium carbide used as poison brought the eels out in great numbers in the Sucubtí. These fish probably are nocturnal, as it is not reasonable to suppose that they always lie buried. Gilbert and Starks (1904, p. 34) stated that they were so abundant in a pond at Miraflores, Canal Zone, that they were trapped for food, yet none could be taken with a seine. This species was reported also from Barro Colorado Island, Canal Zone, by Breder (1933, p. 567).

Breder (1927, p. 131) found the eels both above and below falls in the Rio Sucubtí, which "held back all the other normal river fauna." In explanation he advanced the supposition that the eels probably go overland, through wet grass, around the falls.

This species is not listed in our earlier work (1916) on the fresh-water fishes of Panama, as it was overlooked. However, a description is given in a later publication (1923, p. 131). This description was emended by Breder (1927).

This eel stands in a family by itself, having no near relatives, so far as known. It is readily recognized by the very long body, which greatly exceeds the tail in length; the projecting snout; the rather large mouth, reaching far beyond the eye; the small confluent gill openings, situated on the median ventral line; and the absence of pectoral and ventral fins. The low, membranous dorsal begins a short distance in advance of the vent, and is confluent around the tail with the scarcely developed anal. The color is reported variable. The small specimens at hand are grayish, lighter below than above, the lighter areas underneath being finely dotted with the darker gray of the back. The large specimen is dark brown above, and the grayish under parts are definitely marked with numerous small brownish spots.

The following proportions are based on measurements of the six specimens in the present collection. Tail in head and trunk 2.9 to 3.1; head to gill opening in head and trunk 6 to 6.4; depth in head 2.5 to 3; eye about 10 to 16; snout 6.4 to 6.7; gape from its posterior angle to tip of upper jaw 2.5 to 3.1.

This eel is widely distributed, ranging from southern Mexico to the Amazon and probably southward. It has been taken on both slopes of central and eastern Panama.

Family ANGUILLIDAE

Anguilla rostrata (Le Sueur). COMMON FRESH WATER EEL; "ANGUILLA."

Muraena rostrata Le Sueur, Journ. Acad. Nat. Sci. Phila., 1, p. 81, 1817—New York.

Anguilla rostrata Meek and Hildebrand, Field Mus. Nat. Hist., Zool. Ser., 15, pt. 1, p. 134, 1923.

This species is not listed in our earlier work (1916) because it was overlooked. It is recorded, however, in our work on the marine fishes of Panama (1923, p. 134) from one specimen from the Trinidad River, where it was not rare in 1911 according to native fishermen. Whether it is able to reach this stream since the construction of Gatun Dam has not been determined. If it cannot get by the spillway, it should have no difficulty going through the locks, though no specimens were taken when the locks were dewatered in 1935, and none in Gatun Lake nor tributary streams. Since our earlier investigation it has been reported, however, from nine specimens taken in small streams flowing into Almirante Bay, on the Atlantic slope of extreme western Panama by Behre (1928, p. 310), and Breder (1925, p. 140) listed young ones from the foot of Gatun Spillway, Canal Zone. It has been recorded also from Caldera Island, Porto Bello Bay by Evermann and Goldsborough (1909, p. 101).

The single genus and species of this family occurring in American waters is recognized by the snake-like body, which is covered with scales that are linear, embedded, and arranged in groups placed more or less at right angles to each other. The lower jaw projects somewhat; the gill openings are separate and lateral, partly in front of the base of the pectoral fins; and the dorsal fin begins in advance of the anal a distance nearly equal to the length of the head. The color is uniform greenish above and pale below.

Breeding takes place in deep water at sea. The larvae, generally known as leptocephali, are not eel-like, but are soft, more or less ribbon-shaped transparent creatures with a rather large mouth and large teeth. After spending a year or so in the sea, a metamorphosis takes place, and the young ascend fresh-water streams.

The general range of the common fresh-water eel extends from southern Canada, through the West Indies, to Panama. Species of the genus *Anguilla* occur in nearly all warm seas and adjacent streams, exclusive of the eastern Pacific.

Family POECILIIDAE. Viviparous Top-minnows

The members of this family are viviparous and are characterized by an oblong body, which is more or less depressed anteriorly. compressed posteriorly, and covered with rather large cycloid scales, The head is flat above, the mouth is protractile, the dorsal fin is single and consists of soft rays only, the ventral fins are abdominal, and the anal fin in adult males is variously modified to form an intromittent organ or gonopodium.

As formerly understood this family included many oviparous genera, which have been assigned to a separate family, Cyprinodontidae, by recent authors. Only one genus belonging to the oviparous group, *Rivulus*, occurs in Panama. This genus was placed in the Poeciliidae in our earlier work (1916, p. 330), but is now dealt with separately under the family Cyprinodontidae.

The classification of Hubbs (1924 and 1926) has been followed for the most part. The use of the structure of the intromittent organ (gonopodium) as the principal and often the sole character for generic divisions in these papers has led, in my opinion, to too great a multiplication of genera. This classification makes it difficult at times to separate females of different genera, as pointed out subsequently. It is not the purpose of this paper to carry out generic revisions, but it is apparently proper to state (after having examined and used the classification referred to rather extensively) that it would seem more logical, and that it would simplify classification, if these minnows were grouped generically with reference to the general type of gonopodium, in combination with other characters that would aid in grouping the females also.

The counts of fin rays for the members of this family include the simple rays, which are not shown separately.

The members of this family have proved the most valuable among fishes as enemies of the mosquito. Unfortunately, those species in Panama that seem best suited to cope with the mosquito have not established themselves in abundance, as shown by collections and observations, in the artificial lakes of the Panama Canal. The only minnow of this family that has become very numerous in the lakes is *Mollienisia sphenops*, and it is apparently of limited value, as pointed out in the account of that species.

Gambusia Poey.

A single species of this genus occurs in Panama if the structure of the intromittent organ (gonopodium) is used as a basis for defining

genera. In the present genus this organ is provided near the tip with two rather strong spiny hooks, directed backward and downward. This structure is shown for *G. nicaraguensis* in a camera lucida tracing by Meek and Hildebrand (1916, p. 316, fig. 4).

The close relationship of *G. nicaraguensis* and *Brachyrhaphis cascajalensis* is pointed out in the following account, which shows that closely related species sometimes fall into different genera if the gonopodium is used as the sole basis for founding genera.

Gambusia nicaraguensis Günther.

Gambusia nicaraguensis Gunther, Cat. Fish. Brit. Mus., **6**, p. 336, 1866—Lake Nicaragua; Meek and Hildebrand, Field Mus. Nat. Hist., Zool. Ser., **10**, p. 316, 1916.

Many specimens of this top minnow were collected on Largo Remo Island, at Fort Sherman (Toro Point), Mount Hope Dry Dock, and in Gatun Lake near Gatun and at Barro Colorado Island. In general, this species seems to run smaller in size than *Brachyrhaphis cascajalensis,* with which it sometimes associates and which it resembles greatly. The largest female taken is 45 mm., and the largest male 37 mm. long. In some males the intromittent organ is developed at a much smaller size than in others. For example, a fully mature male only 20 mm. long is at hand, whereas another equal in length to the largest male taken (37 mm.) is not yet fully mature, as the anal fin though considerably modified still does not possess the characteristic hooks of a mature male.

This species, as already suggested, is very similar to *B. cascajalensis,* with which it agrees in the shape of the head and body, the position of the dorsal fin, and the number of scales in a lateral series. However, *nicaraguensis* seems to have 1 or 2 more series of scales between the upper angle of the gill opening and the origin of the dorsal, 14 to 16 being present, whereas only 12 or 13 were counted in *cascajalensis.* Both species have a broad depressed snout, that has the appearance of having been squeezed to a sharp edge between a man's fingers. Adult males are readily distinguished by the differences in the structure of the intromittent organs, that of *nicaraguensis* being provided with distinct hooks distally, which are wanting in *cascajalensis.* The differences are figured by Meek and Hildebrand in camera lucida tracings. (1916, p. 316, fig. 4, and p. 318, fig. 5. Although fig. 5 is based on *B. episcopi* it is representative of *cascajalensis,* as the two are identical in that respect.) The species also differ somewhat in color. *G. nicaraguensis* often has black dots on the upper part of the sides, forming rows along the

series of scales. Similar dots occur on the dorsal and caudal fins, usually forming more or less distinct crossbars. The anal fin is not blotched with black at the base, as in *B. cascajalensis*.

The number of young born at one time seems to be rather small, as in three females examined, respectively 39, 35, and 32 mm. long, the broods consisted of 10, 10, and 4 large embryos in addition to a similar number of large yellow eggs and two or three smaller sets of eggs. No evidence of the development of embryos in a second clutch of eggs before the older embryos are born was seen, as in some of the other local species of this family. The young are well developed, pigmented, and comparatively large when born, as embryos with nearly all the yolk absorbed are about 7 mm. long.

The intestinal tract is very short. Three stomachs examined contained fragments of insects only. This is probably the most useful minnow in Gatun Lake as a natural enemy of the mosquito. It was not secured in Miraflores Lake.

This species ranges on the Atlantic coast from Mexico to Panama and is doubtfully recorded from the Pacific slope of Panama. It inhabits lowland streams and sometimes decidedly brackish to salty water, though it ranges well up into fresh water as shown by its presence in Gatun Lake. On the other hand, the water in the Mount Hope Dry Dock, where it also was taken, is decidedly salty. It is an exceedingly hardy fish, as shown by the survival of a dozen or so individuals confined to a small (about a quart size) can for a period of three days without artificial aeration and without a change of water, whereupon they were placed in a small aquarium in apparently good condition. According to reports received, they lived there for months and multiplied.

Breder (1933, p. 567) listed *Gambusia affinis speciosa* Girard from Barro Colorado Island, Canal Zone, with the remark: "This species is the *Gambusia nicaraguensis* from Panama of authors. Hubbs and Gordon (MS.) identify this fish with the race *speciosa* of *G. affinis*, native of northeastern Mexico and central Texas. Consequently, the present species must be an introduction from early Canal building days for the purpose of mosquito control." I have compared the recently collected specimens from Panama, together with others collected there, by us in 1911 and 1912, with specimens of *Gambusia* from various sections of the United States from New Mexico to the Atlantic coast. None of the males examined from the States have long prominent serrae on the third anal ray like the Panama material. The gonopodium in the Panama speci-

mens before me agrees with the figures given by Hubbs (1926, pl. 2, figs. 1, 2, and 3) for *G. nicaraguensis*, as well as with the figure in our work (1916, p. 316, fig. 4). The Panama specimens, also, are more distinctly marked than the States material, the rows of scales on the sides, at least posteriorly, being rather definitely marked with rows of black dots. Similar dots are prominent on the dorsal and caudal fins also, where they form cross lines. It seems improbable, on the basis of this study, that the Panama material before me is the progeny of an importation. Since writing the foregoing statements concerning the introduction of minnows, I have communicated with Mr. J. A. Le Prince, chief sanitary inspector for the Isthmian Canal Commission from 1904 to 1914. Mr. Le Prince informs me that he knows of only one importation of top minnows, namely, the "millions fish" (*Lebistes reticulata*), which was brought from Barbados, and released in several places now within Gatun Lake. A further discussion of this importation has been given (see p. 225).

Brachyrhaphis Regan.

This genus is characterized by the rather short intromittent organ (gonopodium), which is rather less than a third of the standard length, and which is very simple in structure, having no hooks or spines, as shown by Meek and Hildebrand (1916, p. 318, fig. 5). The body, mouth, and dentition are very similar to *Gambusia*, under which *episcopi* and *cascajalensis* were placed in our earlier publication.

The principal distinguishing characters of the three species collected are pointed out in the accounts that follow.

Brachyrhaphis episcopi (Steindachner).

Gambusia episcopi Steindachner, Sitzber. Akad. Wiss. Wien, 77, p. 387, pl. 2, figs. 3, 4, 1878—Obispo, Canal Zone; Meek and Hildebrand, Field Mus. Nat. Hist., Zool. Ser., 10, p. 317, fig. 5, 1916.

This top minnow, although seemingly fairly common in central Panama during our earlier (1911 and 1912) investigations, was taken in only three places recently; namely, in the Rio Capira at Campaña, in a small creek in El Valle, and in a cloudy pool remaining in a dry creek crossing the road shortly before entering El Valle. This fish alone inhabited the pool mentioned, where it was numerous. Some of the females were larger than any seen previously, the largest one being 64 mm. long. The males, as usual among viviparous fishes, were greatly in the minority, and much smaller, the largest one having a length of only 30 mm.

This species is recognized principally by the greenish color in life, and the black spots along the middle of the side, which may be quadrate, or vertically somewhat elongate, and which in nearly all the specimens from near El Valle are united on the posterior half or two-thirds of the body, forming a continuous black lateral band.

The number of young in a brood seems to be small, but the broods probably are born at short intervals. For example, a female, 33 mm. long, with a greatly distended abdomen, contained 8 large embryos with little yolk, and 12 smaller ones, already in the "eyed" stage, besides eggs of at least three different sizes. Another female, 40 mm. long, but with the abdomen less distended than the one already mentioned, contained only 4 eggs with embryos, and 4 very large eggs without embryos, besides 3 or 4 sets of smaller eggs.

The intestinal tract is very short. The contents of two stomachs examined consisted of insect fragments. This fish probably is of value as a destroyer of mosquito larvae. Unfortunately it does not seem to have established itself in abundance in the artificial lakes of the Canal. Although Hubbs (1926, p. 47) reported "numerous specimens" from Gatun Lake, Barro Colorado Island, I did not take this fish there in two days of seining. I failed also to get it at several other places in Gatun Lake where collections were made, as well as in Miraflores Lake.

This species, unlike its near relative, *B. cascajalensis*, seems to avoid brackish water, confining itself chiefly to somewhat higher altitudes. It is reported from both slopes of central Panama, but not from the Bayano or Tuyra basins. On the Pacific slope of western Panama it is replaced by *B. terrabensis*.

Brachyrhaphis cascajalensis (Meek and Hildebrand).

Gambusia cascajalensis Meek and Hildebrand, Field Mus. Nat. Hist., Zool. Ser., **10**, p. 86, 1913—Rio Cascajal, Porto Bello, Panama; p. 318, 1916.

Specimens were collected at Puerto Pilón; Cativa; Largo Remo Island; Fort Sherman (Toro Point); in Gatun Lake at Gatun and Barro Colorado Island; and in a creek tributary to Gatun Lake, on the Madden Dam Road. In general the specimens run larger in size than those of *Gambusia episcopi*. Females of 50 mm. or more in length, and males 30 mm. and upward are common, the largest female taken being 63 mm. and the largest male 37 mm. long.

This species has a rather more slender body than *episcopi*, as pointed out by us (1916, p. 318). The dorsal fin is more posteriorly placed, and apparently has fewer rays, its origin in females being

over the end of the base of the anal instead of over the middle of the anal, as in *episcopi*. The number of rays is constantly 7 in 19 specimens, whereas in *episcopi* this fin has constantly 8 rays according to 18 specimens examined, if in each species the last partly divided ray is counted as one. Furthermore, the dorsal profile is nearly straight in advance of dorsal instead of notably convex, as in *episcopi*. *B. cascajalensis* also is plainer in color, being grayish and without a lateral band or lateral spots, except in a few small specimens which have faint dark spots. The black on the anal is generally more prominent and spreads over more of the fin.

The intestinal tract is as short as in *episcopi*. Two specimens examined had fed on insects. The species no doubt feeds on mosquito larvae if available, and where numerous enough it probably provides a degree of mosquito control. Although taken in two places in Gatun Lake it did not seem to be numerous, and it was not found in Miraflores Lake. Therefore, it seems to be too rare in the artificial lakes of the Canal to be of much value in controlling mosquito-breeding.

Comparatively large broods of young are apparently produced by large females, as a specimen 58 mm. long contained 49 large embryos. These embryos had absorbed nearly all the yolk and were pigmented almost like the adults. Therefore, they were, no doubt, about to be born. However, no other eggs with embryos were present in this specimen, nor in a smaller one examined, as found in several other species of this family here reported. The smaller female, 43 mm. long, contained only 13 large embryos, besides eggs of two or three different sizes.

During the recent investigation this species was taken only in the Atlantic drainage. Earlier (1911 and 1912), a few specimens were taken in the Pacific drainage of central Panama. It was not secured in the Bayano nor Tuyra basin. Hubbs (1926, p. 47) reported it from pools and shallows in the Rio Nargana, a few miles from the Caribbean Sea, San Blas, Panama. He reported it also from several localities in the Caribbean drainage on both sides of the Panama-Costa Rica boundary. The last-mentioned record was based on specimens collected by Behre, which she also reported (1928, p. 315). This species, therefore, appears to inhabit the Atlantic slope of all of Panama and part of Costa Rica. It seems to be most numerous in lowland pools and streams, occurring at times in brackish water.

Brachyrhaphis terrabensis (Regan).

Gambusia terrabensis Regan, Ann. Mag. Nat. Hist. (7), 19, p. 260, 1907; Biol. Cent. Amer., Pisces, p. 97, pl. 12, fig. 7, 1907—Rio Grande de Térraba, Pacific slope, Costa Rica.

Specimens were collected in a muddy trickle on a mountain side, a short distance from the Rio Chiriquí Viejo, at an elevation of about 5,000 feet, in water less than an inch deep. No native fishes were seen above this elevation in that river basin, which was explored to an altitude of about 7,000 feet. Very brightly colored specimens were collected in quiet places in the clear water of the Rio Barilles (tributary of the Rio Chiriquí Viejo) at an elevation of about 4,800 feet. Others were taken in the near-by lagunas Gulnar and Grande at about the same altitude. The largest female taken is 49 mm. and the largest male has the relatively great length of 42 mm.

In shape of body and color, this species is similar to *Gambusia episcopi*. It is readily separable from that species, as well as from *Brachyrhaphis cascajalensis*, by the longer dorsal fin, which has 13 rays. Its origin also is farther forward, being in advance of the anal in females. Because of the more anterior position of the dorsal only 8 or 9 series of scales are present between the upper angle of the gill opening and the origin of the dorsal, whereas 12 or 13 series may be counted in the other two Panama species of the genus.

B. terrabensis is known only from the Pacific slope of western Panama and from Costa Rica. In addition to the specimens already listed here, Hubbs (1926, p. 43) recorded specimens from the upper part of the Rio Chiriquí del Tire Basin, and others from the vicinity of Boquete. These specimens also in part were listed by Behre (1928, p. 315). Still others from the same general vicinity of Panama were recorded by Hildebrand (1928, p. 83).

Trigonophallus Hubbs.

This genus seems to be close to *Brachyrhaphis*. It is described by Hubbs (1926, p. 48) in part as follows: "This organ (gonopodium) is longer than in *Brachyrhaphis*, being decidedly more than one-third as long as the fish (to caudal fin). The extreme membranous tip is peculiarly hardened and modified into a subtriangular structure, the free tips of which are pointed outward and backward. The distal segments of ray 3, as in neither of the related genera, are produced posteriorly as definite pointed spines. The tips of rays 4 and 5, as in most of the species here referred to *Brachyrhaphis*, are slightly turned backward."

Trigonophallus punctifer Hubbs.

Trigonophallus punctifer Hubbs, Misc. Pub. Mus. Zool., Univ. Michigan, No. 16, p. 49, 1926—Guibari Creek, tributary of Rio Cricamola, Atlantic slope, western Panama.

This species is known only from the type, a male 30 mm. long, and some female paratypes, 27 to 51 mm. long, collected in a tributary to the Rio Cricamola and in the Rio Cricamola, both near Conquantu, and in the upper course of Western River, flowing into Almirante Bay, all from the Atlantic slope of western Panama. The type specimens are recorded also by Behre (1928, p. 316), who collected them. The species was not seen by me. The following description is condensed after Hubbs.

Body moderately deep, rather sharply compressed posteriorly; dorsal contour almost straight from snout to occiput, from there to dorsal moderately convex; tail bent downward dorsally; head 3.3 to 3.7; depth 3 to 3.4; snout 2.8 to 3.35 in head; eye 2.7 to 3.6; interorbital 1.9 to 2.5; caudal peduncle 1.6 to 1.9; mouth partly lateral, the cleft extending more than halfway to eye; maxillary reaching vertical from anterior margin of eye; symphysial knob of mandible protruding beyond upper jaw; teeth firmly fixed, sharply conical, in bands of moderate width, the outer ones enlarged; scales 28 or 29 from upper angle of gill opening to base of caudal; dorsal with 10 or 11 (rarely 9) rays, its origin nearly equidistant from tip of snout and end of middle rays of caudal; caudal truncate; anal with 9 rays (including unbranched ones), its origin slightly in advance of dorsal; ventrals not modified in males; pectoral rounded, 1.3 to 1.5 in head.

Color pale, with a suffusion of dark behind pectorals and on top of head; upper lip blackish; margin of mandible dusky; scale pockets on back and sides narrowly margined with dusky, the dark often intensified at apex, forming inconspicuous rows of dots. Dorsal fin with a row of vertically elongate spots on the membranes near the base, the outer posterior angle of fin dark; caudal dusky, especially toward margin; anal with a submedian blackish blotch.

This species according to the published account seems to resemble *Brachyrhaphis cascajalensis* and *B. episcopi*. It differs from both, however, in the somewhat more numerous dorsal rays, approaching *B. terrabensis* in that respect. In the dark dots on the body it resembles *Gambusia nicaraguensis*, which contrary to the present species also has dark points on the dorsal and caudal fins. In the black blotch on the anal fin and the dark spots near the base of

the dorsal it seems to agree with the species of *Brachyrhaphis* here discussed.

Allogambusia Hubbs.

Allogambusia Hubbs, Misc. Pub. Mus. Zool., Univ. Michigan, No. 13, p. 8, 1924; No. 16, p. 56, 1926 (type *Gambusia tridentiger* Garman).

This genus is described by Hubbs as follows: "Ray 3 (of gonopodium) with a short, suberect, curved spur near tip; anterior branch of ray 4 with a much enlarged node somewhat resembling the 'elbow' of the Gambusiini."

Each jaw has an outer rather close-set series of teeth, followed by a definite band of minute ones; intestinal tract shorter than body; vertebrae about 13+19; intromittent organ (gonopodium) 2.4 to 2.7 in standard length.

The genera *Allogambusia, Darienichthys,* and *Panamichthys* were all carved out of the genus *Priapichthys* as understood by Meek and Hildebrand (1916, p. 319). Therefore, the descriptions of the species, now placed in the three later genera, appear under the genus *Priapichthys* in the earlier work.

Allogambusia tridentiger (Garman).

Gambusia tridentiger Garman, Mem. Mus. Comp. Zool., **19**, p. 89, pl. 4, fig. 10, 1895, teeth only—Isthmus of Panama.

Priapichthys tridentiger Meek and Hildebrand, Field Mus. Nat. Hist., Zool. Ser., **10**, p. 320, fig. 6, 1916.

Many specimens of this species, ranging from 9 to 35 mm. in length, were preserved. The species was taken on the Pacific slope at El Valle; in coastal streams between Campaña and La Venta; Rio Capira at Campaña; creek at Albrook Landing Field; Rio Cocoli; Rio Pacorá; and in swamps at the La Jagua Hunting Club. On the Atlantic side it was secured in Madden Lake at the mouth of the Boquerón; in a creek on Madden Dam Road, flowing into Gatun Lake; and in an abandoned reservoir at Mount Hope. This fish is numerous in some places, as in the swamps near the La Jagua Hunting Club. It does not seem to have established itself in the artificial lakes of the Canal, as it was not secured either in Gatun or Miraflores Lake. Madden Lake had just been formed when the specimens were collected at the mouth of the Boquerón, February 12, 1935. This species was not seen in any of the locks of the Canal when dewatered in 1935 and 1937.

The males are recognized readily by the long intromittent organ with its prominent spur near the apex, visible under comparatively

low magnification. The peculiar structure of this organ is shown in figure 6 by Meek and Hildebrand (1916, p. 321). The females, however, are sometimes not readily distinguishable from those of *Darienichthys dariensis* (*Priapichthys dariensis* in Meek and Hildebrand, 1916, p. 321). In general, the females of the present species have more prominent dark bars, but some specimens are scarcely distinguishable by the color. However, the dorsal fin is constantly a little more anteriorly placed in *tridentiger*, wherein its origin is over or slightly in advance of the base of the last ray of the anal, whereas in *dariensis* the origin of the dorsal is always somewhat posterior to the end of the base of the anal. Although the lateral series of scales is almost identical in number in these species, there is a difference in the number of scales in advance of the dorsal, due to the difference in position of the fin, *tridentiger* having 14 or 15 series of scales between the upper angle of the gill opening and the origin of the dorsal, whereas *dariensis* has 17 or 18. The difference in the number of scales in advance of the dorsal also prevails in adult males, in which the anal fin is situated far in advance of the dorsal in both species. The differences in scale counts and position of the dorsal fin are not shown in our earlier publication (1916).

It is unfortunate that this fish does not seem to have established itself in the artificial lakes of the Canal, as it is undoubtedly an enemy of the mosquito; first, because it lives in quiet waters where mosquitoes ordinarily breed; and, second, because it feeds on insect larvae, as shown by four intestinal tracts examined.

The difference in size at which the anal fin of the male becomes fully modified and ready to serve as an intromittent organ is comparatively great for such a small fish. Males fully mature at a length of 16 mm. have been observed, whereas others at a length of 22 mm. are still immature. In this species, as in many others of this family, the male is much smaller than the female, the largest male in the present collection being 25 mm. long, whereas the largest female has a length of 35 mm., though a female 45 mm. long has been reported.

The young are born at a comparatively large size, fully scaled, and pigmented. Young 6 mm. long were removed from the parent. These fish were fully scaled, and had the color of young free-swimming fish, including a dark lateral line and a black spot on the middle of the side above the base of the anal. Apparently the broods are rather small, but seemingly are born in quick succession. The largest number of embryos found, in four specimens dissected,

was 17 in a female 35 mm. long, whereas a female 22 mm. long contained only 6. One specimen containing large embryos, which had absorbed nearly all the yolk and were undoubtedly about to be born, also contained a set of eggs with smaller, but well-formed embryos, besides less mature eggs. Eggs in at least three different stages of development were present in all examples examined.

The range of this species, so far as known, is limited to the Atlantic and Pacific slopes of central and eastern Panama, or to central Panama, if *Allogambusia cana* (Meek and Hildebrand) from the Tuyra Basin is a distinct species, as considered by Breder (1927, p. 133).

Darienichthys Hubbs.

Darienichthys Hubbs, Misc. Pub. Mus. Zool., Univ. Michigan, No. 13, p. 8, 1924; No. 16, p. 61, 1926 (type *Gambusia dariensis* Meek and Hildebrand).

This genus is described by Hubbs as follows:"Gonopodium rather short, between two-fifths and one-third standard length of body; process at tip of ray 3 more or less retrorse to axis of gonopodium; serrae of posterior branch of ray 4 weak (but more numerous than shown in Meek and Hildebrand's figure)."

Each jaw has an outer series of close-set teeth, followed by a more or less definite band of very minute teeth; intestinal tract very short, not as long as body; vertebrae about 13+20; intromittent organ (gonopodium) 2.7 to 2.9 in standard length.

Darienichthys dariensis (Meek and Hildebrand).

Gambusia dariensis Meek and Hildebrand, Field Mus. Nat. Hist., Zool. Ser., **10**, p. 88, 1913—Rio Capetí, tributary of the Tuyra.

Priapichthys dariensis Meek and Hildebrand, Field Mus. Nat. Hist., Zool. Ser., **10**, p. 321, fig. 7, 1916.

This fish was taken in only two collections during the 1935 and 1937 investigations, namely, those from coastal streams between Campaña and La Venta, and from the Rio Pacorá. Fifty-three specimens, ranging in length from 12 to 38 mm., are at hand.

Although this species has been considered generically distinct by some recent writers, the females are not always easily distinguishable from *Allogambusia tridentiger*, as pointed out in the account of that species. The males are readily distinguishable by the structure of the intromittent organ. In the present species one of the segments of a produced ray is recurved and directed forward, as shown by Meek and Hildebrand (1916, p. 322, fig. 7). Although the females generally are plainer in color than those of *A. tridentiger*,

often having no crossbars, the males have more numerous and more distinct dark bars in the present species. The larger number of rows of scales between the upper angle of the gill opening and the origin of the dorsal, which is 17 or 18, is generally sufficient to separate this species from *A. tridentiger*. Then, too, in females the relative position of the dorsal and anal is different, for in the present species the dorsal begins well behind the end of the base of the anal, whereas in *tridentiger* it begins over or very slightly behind the base of the anal. The differences just mentioned are not included in our earlier publication.

This species is known only from the Pacific slope of central and eastern Panama. In earlier investigations it was taken only in the Rio Juan Diaz, Rio Bayano and Rio Tuyra. The range is now extended to coastal streams between Campaña and La Venta. Breder (1927, p. 133) reported it common in the Chucunaque Basin. It has not yet been found on the Canal Zone.

Panamichthys Hubbs.

The gonopodium is comparatively simple, having no horn-like hooks distally. The tip of this organ is curved abruptly forward to form a sort of hook, which is composed of the closely joined rays 4 and 5. Only ray 4 has a few serrae on its posterior edge, behind which ray 5 is arched somewhat backward (see Meek and Hildebrand, 1916, p. 323, fig. 8).

Panamichthys panamensis (Meek and Hildebrand).

Priapichthys panamensis Meek and Hildebrand, Field Mus. Nat. Hist., Zool. Ser., **10**, p. 322, fig. 8, 1916—Chame Point, Panama.

This species was made the type of a new genus by Hubbs (1924, p. 8). The characters upon which the genus was based are set forth in the generic account and are shown in the figure accompanying our original description.

Although a specimen was taken in the Rio Chame in 1911, the species was not found in 1937, when another collection was made in that river.

A mistake was made in our original description in giving the position of the dorsal fin. This fin, instead of having its origin "midway between posterior margin of the eye and base of caudal," actually originates midway between the posterior margin of the eye and the end of the caudal.

The species is known only from the type material collected in the Rio Chame, near Chame, and in a brackish pool on Chame Point.

Poeciliopsis Regan.

This genus was divided into smaller genera by Hubbs (1926, 63 and 69), who made *P. elongatus* the type of a new genus, *Aulophallus*, which was based principally upon the structure of the mouth, teeth, and intromittent organ or gonopodium. The mouth was described as transverse, that is, without lateral cleft; the teeth as in a single series, hooked inward, very long, hair-like and loose; and the gonopodium "without the 'crescentic horn' (of some other genera) in membranous tip; none of the segments consolidated; two halves of posterior branch of ray 4 closely united, bearing an apparently single series of thorn-shaped serrae; segments of anterior branch of ray 5 more oblique, and greatly widened, as though in compensation for lack of specialization of ray 4." I have no special objection to this division of the genus. However, for convenience and brevity, the following accounts are given under the generic name appearing in our earlier publication (1916, pp. 324–326).

Hubbs (1926, p. 69) said, "In agreement with Günther and in disagreement with Steindachner and Meek and Hildebrand, I find but one row of teeth in *elongatus;* the latter authors have seemingly mistaken some of the fine buccal papillae for teeth." I have removed jaws and teeth from 3 specimens, 1 male and 2 females, in the present collection, and have dried the jaws, to shrink the soft tissues, that the teeth might stand out more prominently. Minute teeth are unmistakably present behind the outer enlarged series in each jaw in the three specimens especially treated and examined. The teeth are similar in shape to the outer ones, but so much smaller that they could be easily overlooked.

Poeciliopsis elongatus (Günther).

Poecilia elongata Günther, Cat. Fish. Brit. Mus., **6**, p. 342, 1866—Panama.

Poeciliopsis elongatus Meek and Hildebrand, Field Mus. Nat. Hist., Zool. Ser., **10**, p. 324, fig. 9, 1916.

This species is represented by 81 specimens, ranging from 18 to 140 mm. in length. Many others were taken but not preserved. It is common to numerous in salt and brackish water and ranges to fresh water, which it apparently scarcely enters. The specimens at hand were taken at Farfan Beach in the mouth of a tidal stream, and in the hull of a sunken vessel, which was under water at high tide, but exposed and dry except for small pools within the hull at low tide. Numerous individuals of this species occupied the pools in the hull. It was also taken in small coastal streams between Campaña and La Venta, and many individuals were stranded or occupied the "man

holes" in the floor of Miraflores Locks, in both the upper and lower chambers of the west side, when dewatered in 1937. As none were seen or taken in Pedro Miguel Locks, it would appear that this fish does not advance so far into fresh water.

The chief recognition marks are the rather long slender body, a moderately depressed head, transverse mouth, and the position of the dorsal and anal fins, which are placed opposite each other, the dorsal, however, beginning a little behind the origin of the anal in the young, as well as in adult females. In adult males the anal fin is greatly modified; it is far in advance of the dorsal and some of the rays are greatly produced, much longer than head, forming of course the intromittent organ, which is not prominently provided with hooks as in most other species of this family. A camera lucida tracing of this organ is shown by Meek and Hildebrand (1916, p. 325, fig. 9); the ventral fins are unmodified in males. Large females often are plain grayish, but smaller specimens, and especially the males, have black crossbars on the posterior part of the body. In the young the bars are fewer, far apart, intensely black, and present anteriorly as well as posteriorly.

The fish appear to be largely herbivorous, judging from the contents of three stomachs examined and by the weak hair-like teeth. The alimentary canal, however, is not long or convoluted as in most herbivorous species. The teeth consist of an outer row of very slender movable teeth curved inward, followed by extremely minute teeth of similar shape. The jaws are very weak.

The young are born at a large size. Examples removed from the ovary of a female, 140 mm. long, had attained a length of 16 mm. They were fully scaled, and already had 4 or 5 black crossbars. The fish undoubtedly are born about this size, as free-swimming specimens only 18 mm. long were taken. In addition to 16 large embryos, the 140 mm. fish contained 35 younger embryos, all already in the "eyed stage," and about 7 mm. long, as well as some large eggs. A smaller female, 90 mm. long, contained five large embryos, and five smaller ones in the "eyed stage"; also some large eggs. The indications are that the broods are born in rapid succession, but that the number in a brood is considerably smaller than in some of the other species of the family, as, for example, in *Gambusia affinis* of the United States, in which broods of 50 are common, and broods of upward of 100 or even 200 have been found.

This top-minnow reaches a comparatively large size, females 150 mm. long and males 60 mm. long having been taken in Panama.

This species is apparently confined to the Pacific coast of Costa Rica and western and central Panama. It has not been reported from as far east as the Tuyra Basin.

Poeciliopsis pittieri (Meek).

Poecilia pittieri Meek, Field Mus. Nat. Hist., Zool. Ser., **10**, p. 71, 1912—La Junta, Costa Rica.

Poeciliopsis isthmensis Regan, of which an account was given in our earlier work (1916, p. 325), though not taken by us, was synonymized with *P. pittieri* Meek, by Hubbs (1926, p. 70), who placed the species in his new genus *Phallichthys,* also carved out of the older genus *Poeciliopsis.* Behre secured specimens in Costa Rica and also in the Atlantic drainage of extreme western Panama, which were listed by Hubbs (1926, p. 71) and by Behre (1928, p. 316). Breder (1925, p. 141) "questionably referred to this species" a young female taken in a foul drainage ditch below Gatun Spillway. Having collected rather extensively in 1911 and 1912, and again in 1935 and 1937, in the vicinity of Colón, from whence the types of *P. isthmensis* were reported, I am obliged to conclude that the species either is very rare there, or that a mistake was made in the earlier record. However, the species now unquestionably belongs to the fauna of Panama on the basis of specimens collected in western Panama, to which reference has been made.

Poeciliopsis retropinna (Regan).

Poecilia retropinna Regan, Ann. Mag. Nat. Hist., (8), **2**, p. 458, 1908—Brocura, Costa Rica.

Aulophallus retropinna Hubbs, Misc. Pub. Mus. Zool., Univ. Michigan, No. 16, p. 69, 1926.

Head 4.5; depth 3.5; D. 9; A. 10; scales 30; snout as long as eye, 3.5 in head; origin of dorsal equidistant from front of eye and end of caudal fin; caudal rounded; origin of anal a little in advance of dorsal; pectorals nearly as long as head. Color olivaceous; scales with dark edges; fins pale (condensed after Regan).

A single specimen, a female 77 mm. long, was known until Hubbs (1926, p. 69) reported it from some tributaries of the Rio Chiriquí del Tire, Pacific slope of western Panama, from specimens collected by Behre, which she also listed (1928, p. 316). Hubbs found the structure of the gonopodium identical with that of *elongatus,* and placed it in his new genus *Aulophallus* with *elongatus.*

This species seems to differ from *elongatus,* as far as may be judged from the inadequate accounts, principally in the plainer

color, no crossbars or spots being present. It may be noted here, however, that large females of *elongatus*, too, are without bars. The habitats seem to differ, as *elongatus* lives in lowlands and brackish water, whereas *retropinna* was taken in the mountains of western Panama.

Mollienisia Le Sueur.

This genus is characterized principally as follows: body moderately robust, compressed posteriorly; mouth small, transverse, with weak teeth in bands in the jaws, the outer ones enlarged and movable; intromittent organ short, preceded by a membranous hood, distally with an antrorse and a retrorse hook; ventral fins modified in males, the first articulated ray being produced. The dorsal fin is sometimes very high in adult males.

Four species were listed in our earlier work (1916, pp. 326–330) under this genus. Two of those listed, namely, *formosa* from Colón, and *cuneata* from Turbo, Gulf of Darien, had not been taken by us, and have not been secured by collectors since that time. However, Breder (1927, p. 135) took *caucana* (made the type of a new genus, *Allopoecilia*, by Hubbs, 1924, p. 11), in small tributaries of the Rio Sucubtí (Tuyra Basin), Darien, Panama.

Mollienisia sphenops (Cuvier and Valenciennes).

Poecilia sphenops Cuvier and Valenciennes, Hist. Nat. Poiss., **18**, p. 130, pl. 526, 1846—Vera Cruz, Mexico.

Mollienisia sphenops Meek and Hildebrand, Field Mus. Nat. Hist., Zool. Ser., **10**, p. 326, fig. 10, 1916.

Numerous specimens of this common fish were preserved. It was taken on the Pacific slope in swamps at the La Jagua Hunting Club; in the Rio Pacorá and the Rio Cabra; at Fort Kobbe; and in Miraflores Lake and the Rio Cocoli, a short distance above the lake. On the Atlantic side it was taken at Puerto Pilón; Largo Remo Island; Cativa; Fort Sherman (Toro Point); Mount Hope; in several places in Gatun Lake (including Barro Colorado Island); in a small stream on Madden Dam Road; and in Madden Lake, at the mouth of the Boquerón. Next to *Astyanax ruberrimus*, it is the most numerous fish in the waters of Panama. It ranges from lowland brackish water swamps and streams (being able to endure more salt than *A. ruberrimus*) to upland rivers and creeks, generally occupying quiet, shallow water. Large males, with high dorsal fins with black spots, and generally with blue, greenish, and silvery iridescence are prized as "pet fish" and a limited number are shipped to Europe for use in aquariums.

The species is adequately described by Meek and Hildebrand (1916, p. 326). The chief recognition marks are the depressed head, robust body, and deep, strongly compressed tail. The dorsal and anal fins are opposite each other in the young and adult females, the former beginning a little in advance of the latter, and always marked with dark dots or blotches. In adult males the anal fin moves far forward in the course of development, becoming situated considerably in advance of the dorsal. It is modified to serve as an intromittent organ (gonopodium) for the transfer of the sperms from the male to the female. The members of this genus differ notably from other local forms, except *Alfaro,* in the structure of this organ, which is covered or preceded distally by a sort of membranous hood. The structure is figured by Meek and Hildebrand (1916, p. 328, fig. 10). The ventral fins, too, are modified in adult males, the first (outer) articulated ray being produced. The dorsal fin in some males, at least, becomes greatly elevated.

As the Atlantic and Pacific slope members of *M. sphenops* cannot be distinguished, it is impossible to determine from specimens if intermingling has taken place through the Canal. However, there is apparently nothing to prevent it. Nevertheless, this fish was not taken in the locks.

The great difference in the size of the males at which the anal fin becomes fully modified, and ready to function as an intromittent organ, is remarkable. For example, a male only 32 mm. long has the organ fully developed, whereas in another male 55 mm. long it is still immature. Although males do not seem to grow quite as large as females, the disparity is not as great as in most groups of this family. Females 100 mm. long, and males upward of 75 mm., have been taken in Panama.

Although this fish generally occupies areas suitable for mosquito-breeding, it probably is not a very effective enemy of the mosquito, as it tends too much to feed on algae.

Attempts have been made to split up *sphenops* from different areas into species or subspecies. However, insufficient work has been done to demonstrate the divisions, if indeed they exist. As now understood the species may be regarded as ranging from Mexico, on both slopes of Panama to Colombia. Meek and Hildebrand did not take it in the Tuyra Basin, but Breder (1927, p. 134) recorded it from there, having taken it in the headwaters of the Rio Sucubtí and its tributaries.

Mollienisia caucana (Steindachner).

Girardinus caucana Steindachner, Denkschr. Akad. Wiss., Wien, **42**, p. 87, pl. 6, figs. 4, 5, 1880—Cáceres, Colombia.

Mollienisia caucana Meek and Hildebrand, Field Mus. Nat. Hist., Zool. Ser., **10**, p. 329, 1916.

This species is known in Panama only from the Tuyra Basin, where we collected it in 1912 in a few of the upper tributaries of the Rio Tuyra, and where Breder later collected specimens in small tributaries of the Rio Chucunaque, which he recorded (1927, p. 135) as *Allopoecilia caucana*.

Although this species has been made the type of a new genus, *Allopoecilia* (Hubbs, 1924, p. 11), the writer prefers to leave it with *Mollienisia*, as the differences in the structure of the gonopodium, upon which the new genus was based, appear too trivial to constitute generic characters. The two species, *sphenops* and *caucana*, indeed are closely related, as shown in our earlier work (1916, p. 329).

This species is known from the Tuyra Basin, Pacific slope in eastern Panama, and from the Atlantic slope of Colombia.

Mollienisia cuneata (Garman).

Poecilia cuneata Garman, Mem. Mus. Comp. Zool., **19**, p. 62, pl. 5, fig. 3, 1895—Turbo, Gulf of Darien.

Mollienisia cuneata Meek and Hildebrand, Field Mus. Nat. Hist., Zool. Ser., **10**, p. 329, 1916.

This species, regarded by Hubbs (1926, p. 77) as a subspecies of *M. sphenops*, was included in our earlier work on the basis of its description from Turbo, Gulf of Darien. It has not been taken in Panama by recent collectors. Hubbs (loc. cit.) considers Colombian material as belonging to *cuneata*.

Mollienisia formosa (Girard).

Limia formosa Girard, Proc. Acad. Nat. Sci. Phila., p. 115, 1859—Palo Alto, Mexico.

Mollienisia formosa Meek and Hildebrand, Field Mus. Nat. Hist., Zool. Ser., **10**, p. 330, 1916.

This species was included in our earlier work on the basis of a record by Regan (1913, p. 1012), who listed it from Colón. It has not been taken in Panama by recent collectors.

Hubbs and Hubbs (1932, pp. 628–630) have claimed that *M. formosa* is a hybrid, resulting from a cross between *sphenops* and *latipinna*. If that be true, *formosa* could not occur in Panama, as *latipinna* does not range southward to the Isthmus of Panama.

The habitat of *M. formosa* generally has been given as the Atlantic slope of Mexico and Central America.

Alfaro Meek.

This genus differs from all other genera of this family known from Panama in the presence of a sharp keel along the lower edge of the caudal peduncle, the keel being formed by a double series of paired scales. The intromittent organ is somewhat similar to that of *Mollienisia*, being short and preceded or covered anteriorly by a membranous hood. Unlike *Mollienisia*, however, it is without hooks or retrorse spines.

This genus is not included in our earlier work. It is added here on the basis of specimens collected on the Atlantic slope of extreme western Panama, as shown subsequently.

Alfaro cultratus (Regan).

Petalosa cultratum Regan, Ann. Mag. Nat. Hist., (8), 2, p. 458, 1908—Rio Iroquois, Costa Rica.

This species belongs to the fauna of Panama on the basis of specimens collected on the Atlantic slope of extreme western Panama by Dr. E. H. Behre. These specimens were recorded by Hubbs (1926, p. 79) and by Behre (1928, p. 317).

Head 3.8 to 4.3; depth 3.1 to 3.7; D. 7 or 8; A. 9 or 10; scales 32 to 34. Body much compressed, profile from nape to dorsal straight; head flat above; snout 2.7 to 3.2 in head; eye 2.7 to 3.1; dorsal fin on posterior third of body; pectorals broad, 1.2 to 1.4 in head. Color olivaceous, no spots or bars; vertical fins slightly dusky (condensed after Meek's description of *A. acutiventralis*, a synonym of *cultratus*).

This species differs from all other species of the family known from Panama, in the sharp keel along the lower edge of the caudal peduncle, formed by double series of paired scales, which is a character considered of generic importance.

Family CYPRINODONTIDAE

Body elongate, compressed, at least posteriorly; mouth small, terminal; premaxillaries protractile; teeth pointed or more or less incisor-like; gill membranes united, free from the isthmus; gill rakers short and thick; scales moderately large, cycloid; no lateral line; dorsal fin single, with soft rays only; caudal square to more or less pointed, not forked; anal somewhat similar to dorsal, not modified in male; ventrals abdominal, species oviparous.

A single genus is known from Panama, namely, *Rivulus*, which was included in the family Poeciliidae in our earlier work. The oviparous species now are separated from the viviporous ones under the family name appearing herewith by nearly all ichthylogists.

Rivulus Poey.

The fishes of this genus are slender, generally depressed anteriorly, but always compressed posteriorly. The head is low and flat above; the mouth is small and forms a vertical groove in front of the very narrow preorbital; the teeth are villiform, generally present on the vomer and always in bands in each jaw, the outer ones generally being somewhat enlarged. The fins are rounded; the caudal is square to pointed, and occasionally more or less notched at the end of the upper or lower rays in males. The dorsal is small and is inserted far back over the posterior part of the much longer anal. The coloration generally is rather plain, the females often having an ocellus at the base of the upper caudal rays.

The species are very slimy when removed from the water. They are difficult to seine, as they seem to escape by clinging close to the bottom, or by finding protection under or among objects in the water. Many more fish were seen in pools in a creek on Barro Colorado Island, Canal Zone, for example, than were captured by repeated seining.

Only two species of this genus were included in our earlier work. The number of species found has increased to five, two of which apparently require names. Because of the additions made, a key to the species is introduced.

KEY TO SPECIES OF RIVULUS

a. Caudal fin broadly rounded to nearly square.

b. Scales rather large, 33 to 40 in lateral series between upper angle of gill opening and base of caudal, 7 or 8 complete longitudinal rows between bases of dorsal and anal.

c. Body moderately robust, depth 4.5 to 5.2, and depth of caudal peduncle 7 to 7.75 in standard length in adults; scales 33 to 37; general color brownish . *brunneus.*

cc. Body slender, depth 5.5 to 6, and depth of caudal peduncle 8.2 to 9 in standard length; scales 38 to 40; general color bluish. *chucunaque.*

bb. Scales smaller, 42 to 45 in lateral series between upper angle of gill opening and base of caudal, 10 or 11 complete rows between bases of dorsal and anal.

d. Head only moderately depressed, not much broader than deep, its greatest width 1.4 to 1.5 in its length; interorbital 3.3 to 3.9 in head; pectorals rather long, reaching about three-fourths to ventrals; color brownish, with pale markings; vertical fins with black spots. *volcanus*, sp. nov.

dd. Head strongly depressed, notably broader than deep, its greatest width 1.3 in its length; interorbital 2.9 in head; pectorals short, reaching only halfway to ventrals; color plain, scales slightly dark-edged; vertical fins plain or with light spots.......*hildebrandi.*

aa. Caudal fin moderately pointed; body slender, depth 5 to 6, and depth of peduncle 7.6 to 8.6 in standard length; scales 33 to 38 in lateral series, between upper angle of gill opening and base of dorsal, 8 or 9 complete longitudinal series between bases of dorsal and anal...*montium,* sp. nov.

Rivulus brunneus Meek and Hildebrand.

Rivulus brunneus Meek and Hildebrand, Field Mus. Nat. Hist., Zool. Ser., **10**, p. 86, 1913—Toro Point, Canal Zone; ibid., p. 331, 1916.

Six specimens, ranging in length from 18 to 50 mm., were collected in pools left in a creek near the end of the dry season, on Barro Colorado Island.

The following measurements and counts are based on four specimens taken on Barro Colorado Island, and on four paratypes. Head

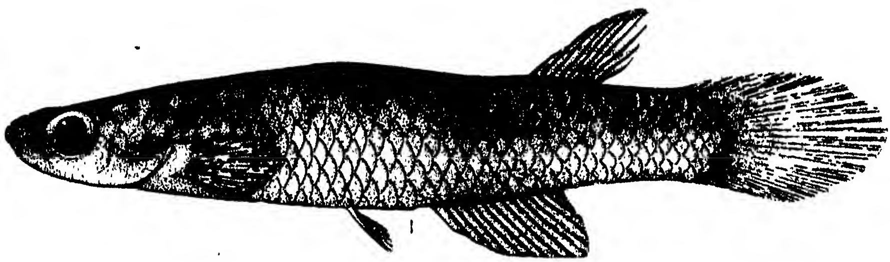

FIG. 7. *Rivulus brunneus* Meek and Hildebrand. Male specimen, 50 mm. long. (From drawing by Andrew Pizzini.)

3.4 to 4.1; depth 4.5 to 5.2; D. 9 or 10; A. 12 to 14; scales 33 to 37, complete rows between bases of dorsal and anal 7 or 8. Eye 3.5 to 3.75 in head; interorbital 2.8 to 3.2; caudal peduncle 1.9 to 2.2 in head, or 7 to 7.75 in standard length; pectoral 1.5 to 1.7 in head. Ventrals fully as long as eye, reaching vent.

This species is known only from the Atlantic slope of the Canal Zone, where it inhabits small creeks.

Rivulus chucunaque Breder.

Rivulus chucunaque Breder, Amer. Mus. Nat. Hist., Nov., No. 180, p. 7, fig. 6, 1925—Rio Chucunaque Basin, Darien, Panama; Bull. Amer. Mus. Nat. Hist., **57**, p. 135, fig. 8, 1927.

This species was described from specimens taken in a small side stream of the Rio Chucunaque, Darien, by Breder. I have made a direct comparison of paratypes of this species and paratypes of *brunneus*. These species are closely related, as suggested by Breder,

who stated that the chief difference seemed to be that of color, *brunneus* being brownish with black dots, which are faint on the dorsal and caudal fins, whereas *chucunaque* is pale bluish, sprinkled with pink dots forming more or less distinct lines along the rows of scales, having no caudal ocellus, the dorsal and caudal being profusely marked with dark spots.

Upon comparison of specimens of equal size it is evident that *chucunaque* is a more slender fish. Proportional measurements overlap partly because small specimens (juveniles) are more slender than large ones. In four paratypes of *chucunaque* ranging in length from 38 to 45 mm., the depth is contained in the standard length 5.5 to 6 times, and the caudal peduncle 8.2 to 9 times, whereas in five specimens of *brunneus*, ranging in length from 40 to 50 mm., the same proportions are, respectively, 4.5 to 5.2, and 7 to 7.75.

The average number of oblique rows of scales between the upper anterior angle of the gill opening and the base of the caudal seems to be somewhat greater in *chucunaque*. The number in four paratypes counted ranges from 38 to 40, whereas in eight specimens (including four paratypes) of *brunneus* the range is from 33 to 37.

Mr. Breder recognized a subspecies of *chucunaque*, naming it *sucubti*, the type material having been taken in a small side stream of the Rio Sucubtí, Darien. This subspecies is slightly more robust than the typical subspecies, according to Mr. Breder, though that is not evident from the particular paratypes examined, the ventral and vertical fins tend to be longer, and the dark spots on the dorsal, caudal, and anal fewer and larger. In general, this subspecies seems to be rather closer to *brunneus* than the typical subspecies.

R. chucunaque, including both subspecies, is known only from the type material from the Chucunaque Basin, Darien, Panama.

Rivulus volcanus sp. nov.

Rivulus isthmensis Hildebrand (not Garman), Copeia, No. 168, p. 84, 1928—Lagunas Verde, Grande, and Gulnar, Chiriquí, Panama.

Type from Laguna Grande (or Davis), Chiriquí, Panama. No. 106509 United States National Museum. Male. Length 44 mm.

Description of the type.—Head 3.7; depth 5.8; D. 9; A. 14; scales (oblique series between upper angle of gill opening and base of caudal) 45, complete longitudinal rows between bases of dorsal and anal 11.

Body slender, scarcely depressed anteriorly, compressed posteriorly; caudal peduncle strongly compressed, 8.1 in standard length,

2.2 in head; head moderately depressed, somewhat broader than deep, its greatest width 1.5 in its length; snout moderately short, 4.3 in head; eye wholly lateral, 3.6; interorbital (bone) about equal to diameter of eye; scales small, rather difficult to enumerate, enlarged on head, reduced on chest, extending somewhat on base of caudal; dorsal small, the rays reaching first rudimentary ray of caudal, its origin about over beginning of last third of anal; caudal broadly and evenly rounded, about as long as head; anal rather long, ending nearly under middle of base of dorsal; ventrals small, scarcely as long as eye, failing to reach vent; pectorals broadly rounded like the caudal, reaching nearly three-fourths the distance to the ventrals, 1.6 in head.

Color of preserved specimen brownish above, pale below; the brownish color broken somewhat by irregular pale markings; dorsal, caudal, and anal all marked with dark spots, the ones on margin of

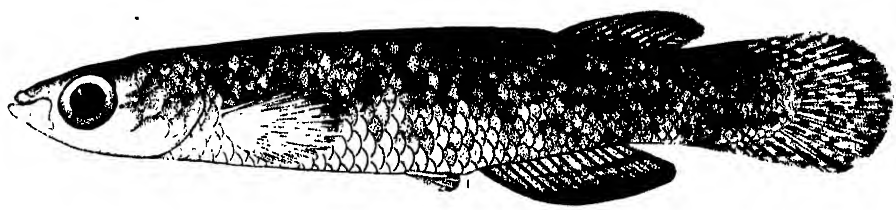

FIG. 8. *Rivulus volcanus* sp. nov. Type, male, 44 mm. long. (From drawing by Andrew Pizzini.)

anal tending to coalesce, forming a dark border; ventrals and pectorals plain.

Variations within the species, as shown by the paratypes, are as follows (measurements and counts are based on nine specimens, unless otherwise stated, ranging in length from 35 to 44 mm.): Head 3.7 to 4.1; depth 5 to 5.8; D. 9 or 10; A. 13 to 15 (13 in 3, 14 in 10, and 15 in 4 specimens); scales (oblique series between upper angle of gill opening and base of caudal) 42 to 45, complete longitudinal series between bases of dorsal and anal 10 or 11. Snout 4.3 to 5.2 in head; eye 3.3 to 3.7 interorbital (bone) 3.3 to 3.9; width of head 1.4 to 1.5; caudal peduncle 2.2 to 2.6; pectoral 1.5 to 1.6.

The females, which are greatly in the majority in the collection, in general appear to be a little more robust than the males and the vertical fins are a little lower. They are a little lighter in color, have a definite ocellus on the upper part of the base of the caudal, and some of them have the anal definitely margined with

black. The spotting on the vertical fins is the same as in males, except that in a few females the black dots form indefinite and irregular bars. A fresh specimen is described in my field notes as grayish green above, and pale to orange below.

This species differs from *hildebrandi*, recorded from the same general vicinity, namely, Boquete, Panama, in being less robust, in having a narrower and less depressed head, longer snout, narrower interorbital, longer pectoral, and being less plain in coloration.

The specimens were compared, also, with specimens in the National Museum identified as *isthmensis*, taken at San José (the type locality of *isthmensis*), Miravalles, and Ochomago, Costa Rica. The Panama specimens are near relatives of this Costa Rican species, but the former differ in (*a*) the more slender body, (*b*) narrower head, (*c*) more numerous scales, and (*d*) in having the body light-spotted instead of dark-spotted. Most of the Costa Rican specimens have enlarged black spots on the sides posterior to the pectorals. Though the vertical fins are dark-spotted in both species, the spotting is finer and more profuse in the Panama specimens. The following proportions are based on 8 and the counts on 12 specimens of *isthmensis:* Head 3.6 to 4.1; depth 4.1 to 4.8; D. 8 or 9; A. about evenly 13 or 14; scales 35 to 39, longitudinal rows between dorsal and anal 8 or 9. Snout 4.5 to 5.3 in head; eye 3.6 to 4.2; interorbital (bone) 2.6 to 3; caudal peduncle 2 to 2.1; pectoral 1.5 to 1.75.

The present collection contains 40 specimens, ranging in length from 12 to 44 mm., consisting of 3 males, 33 females, and 4 juveniles. A few of these specimens were seined in Laguna Gulnar, the rest in a shallow weedy cove of Laguna Grande, where the species was common. These lakes are at an elevation of about 4,500 feet, and supposedly occupy extinct volcanic craters. In addition, the specimens (not in good condition now), reported upon by me as *isthmensis* (1928, p. 84) from Chiriquí, were re-examined. This lot contains a specimen 76 mm. long, therefore much larger than any secured recently.

The species is named *volcanus* after the volcanic lakes in which it lives. The name, Volcán, also is applied to the general vicinity in which the lakes occur.

Rivulus hildebrandi Myers.

Rivulus hildebrandi Myers, Ann. Mag. Nat. Hist., (9), 19, p. 123, 1927—Boquete, Chiriquí, Panama.

This species differs from other species from Panama according to the examination and direct comparison of a paratype, a male

60 mm. long (U.S.N.M. No. 92958), in (*a*) the robust body, which is depressed anteriorly; (*b*) the very short, broad head; (*c*) the very short, blunt snout; (*d*) the broad interorbital; (*e*) the short pectoral, which reaches only half the distance to the base of the ventral; and (*f*) the rather plain coloration, the scales being slightly dark edged, the dorsal, caudal, and anal being faintly light-spotted, the last having a dark margin. The original description states that the fins in females are plain, and have a small ocellus on the upper part of the base of the caudal.

The following proportions and counts are based on the paratype examined: Head 4.25 in standard length, depth 4.75; caudal peduncle 7.25; predorsal length 1.35; pectoral 6.5; D. 9; A. 12; scales in 42 oblique series between upper anterior angle of gill opening and base of caudal, and 11 complete longitudinal rows between the bases of the dorsal and anal. The scale counts in lateral series are given as 49 to 50 in the original description. The difference may result from the place the counts are made. Myers may have counted from the occiput, whereas I counted from the upper angle of the gill opening. Snout about 4.6 in head; eye 3.3; interorbital (bone) 2.9; width of head 1.3; caudal peduncle 1.8; pectoral 1.55. Ventrals a little shorter than diameter of eye, reaching only half the distance to vent; origin of dorsal slightly posterior to middle of base of anal.

This species is known only from the type specimens from Boquete, Chiriquí, Panama.

Rivulus montium sp. nov.

Rivulus elegans Meek and Hildebrand (not Steindachner), Field Mus. Nat. Hist., Zool Ser., **10**, p. 331, 1916.

Type from a hillside trickle between Rio Boquerón and Rio Pequeni, (Chagres Basin), Panama. No. 34880 Museum of Comparative Zoology. Total length 63 mm., standard length 50 mm.

Description of the type.—Head 3.8; depth 5.25; D. 9; A. 12; scales (oblique series between upper angle of gill opening and base of caudal) 38, complete longitudinal rows between bases of dorsal and anal 9.

Body about as broad as high anteriorly, strongly compressed posteriorly; depth of caudal peduncle 8 in standard length, 2.1 in head; head depressed, notably broader than deep, its greatest width 1.55, and its depth 1.9 in its length; snout broader than long, its length 4.3 in head; eye lateral, 4.35, interorbital 3.25; scales in regular series, enlarged on head, somewhat reduced on chest, and extending on basal third of caudal; dorsal rather high, the rays

graduated, next to the last one longest, reaching nearly to rudimentary rays of caudal, its origin over middle of base of anal; caudal fin long, not notched, moderately pointed, the middle rays longest, about as long as head; anal rather high posteriorly, the longest rays equal to those of dorsal, and as long as postorbital part of head, its base ending slightly in advance of end of base of dorsal; ventrals scarcely longer than eye, reaching almost to vent; pectorals with rounded margins, reaching only slightly more than half the distance to base of ventrals, 1.75 in head.

Color grayish brown above, pale gray underneath; posterior half of sides with inconspicuous dusky spots. The vertical fins somewhat darker than the upper parts of the body; dorsal and anal with dark spots which are inconspicuously present on the base of the caudal also. Ventrals pale, with dusky outer margins; pectorals slightly dusky, especially distally.

The variation within the species, as shown by the type and six paratypes ranging in length from 32 to 53 mm., is as follows: Head 3.7 to 4.1; depth 5 to 6; D. 8 or 9; A. 12 or 13; scales 33 to 38, complete longitudinal rows between bases of dorsal and anal 8 or 9. Snout 4 to 5.2 in head; eye 3.75 to 4.6; interorbital 2.8 to 3.4; width of head 1.4 to 1.6; depth of head 1.7 to 2.3; caudal peduncle 1.9 to 2.2 in head, or 7.6 to 8.6 in standard length; pectoral 1.4 to 1.7 in head.

The single adult female at hand, 44 mm. long, has a dark ocellus at the base of the upper rays of the caudal. It is rather lighter in color than the adult males, and in contrast with the males it has dark markings on the anterior part of the body, which tend to form lines along the rows of scales; posteriorly, contrary to the males, dark spots are missing, except for a few at the base of the caudal. The dorsal bears black spots as in the male, but the caudal is plain dusky, and the anal is very pale at the base, becoming dusky along the margin. The ventrals are pale, and the pectorals are only slightly dusky. Immature fish are all more or less speckled with dark specks; lower part of caudal with or without a black longitudinal stripe, forming an intramarginal band.

The dorsal and anal fins are not quite as high in the adult female as in large males, though similar in shape, and the caudal fin is about equally pointed.

The immature specimens, 26 to 38 mm. long, from a small stream on the Atlantic slope near the summit of the ridge, at Culebra,

Canal Zone, collected in 1911, and listed as *R. elegans* by us (1916, p. 331) were re-examined, and appear to belong to the present species.

This species differs from *R. elegans*, following the original description and figure (Steindachner, 1880; p. 33, fig. 6) (*a*) in the pointed caudal fin, which is shown as somewhat concave in Steindachner's figure of *elegans*, though described as broadly rounded to square; (*b*) in the apparently fewer anal rays, that is, 11 or 12 in the present species, and 13 to 15 in *elegans;* (*c*) in the fewer scales on the base of the caudal, present only on the basal third of the fin, whereas in *elegans* they cover the basal half; (*d*) the pectoral fins are shorter as they reach within half an eye's diameter of the base of the ventrals in *elegans*, whereas the space between these fins in the adults of the present species exceeds the full diameter of the eye; and (*e*) in color, the species differing principally in the color of the spots on the body, which are dark or black in the present species, whereas they are

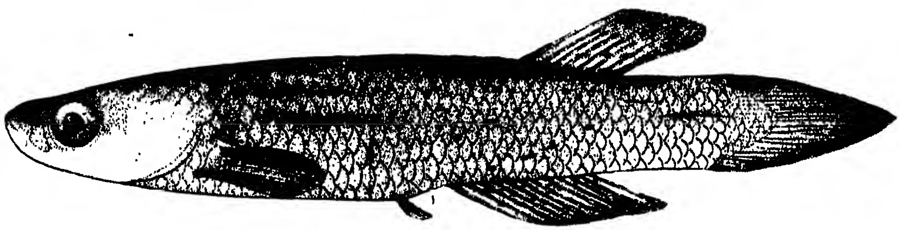

FIG. 9. *Rivulus montium* sp. nov. Type, male, 66 mm. long. (From drawing by Andrew Pizzini.)

indicated in Steindachner's figure as pale, and most distinct on the third and fourth row of scales below the base of the dorsal. The anal fin in males is distinctly spotted with black in the present species. No spots are shown on this fin in Steindachner's figure, which is presumably based on a male, as no caudal ocellus is shown.

This species apparently lives in small mountain streams, and to date is known only from the Chagres Basin from the type and six paratypes taken in a mountain trickle on the ridge between the Rio Pequeni and the Rio Boquerón (upper tributaries of the Chagres) by J. A. Griswold, and from 22 immature specimens taken in very small streams on the Atlantic slope near the summit at Culebra by us in 1911. The specimens taken by Mr. Griswold were sent to the Museum of Comparative Zoology for identification, and were lent for study through the kindness of W. C. Schroeder, curator of fishes in that museum. The type has been deposited in the Museum of Comparative Zoology, as already shown, but some of the paratypes

will be retained, with the permission of Mr. Schroeder, for the National Museum.

As this species has been taken only in the mountains it is here named *montium*.

Family MUGILIDAE. Mullets; Liza; Dajao

Agonostomus Bennett.

The fresh-water mullets of this genus are known quite generally as "dajao" in Central America and the West Indies. They resemble the marine mullets in many respects, but differ in having a normal stomach, not gizzard-like as in the marine forms. The walls in *Agonostomus*, nevertheless, are rather thick. The mouth is larger, with heavier lips, the cleft extending laterally to or beyond the front of the eye, and the lower jaw is rounded (not angulate) anteriorly. The anal fin has only two spines that are free distally. However, a third, undivided ray is attached to the first divided or articulated ray. The young of the marine mullets have the third ray similarly constructed shortly before it becomes a definite spine with a sharp point. In *Agonostomus* the third ray apparently never becomes a definite spine. The anal formulae, as generally written, therefore, show only two spines, the third ray being included with the ones divided.

Two species which may prove to intergrade, namely, *monticola* and *macracanthus*, are recorded from Panama. *A. macracanthus* is apparently rare and differs from the more common one only in having a somewhat deeper body and a larger mouth.

Agonostomus monticola (Bancroft).

Mugil monticola Bancroft, in Griffith's Edition of Cuvier's Animal Kingdom, Fishes, p. 367, pl. 36, 1836—West Indies.

Agonostomus monticola Meek and Hildebrand, Field Mus. Nat. Hist., Zool. Ser., **10**, p. 334, 1916.

This species was taken in 1935 and 1937 at Fort Sherman (Toro Point), and in the Rio Cocoli, a tributary of Miraflores Lake, Canal Zone. It is evident, therefore, that the species occurs in both the Atlantic and Pacific drainages, which it also did before the opening of the Canal. As the species is apparently confined to rocky streams it probably seldom if ever enters the Canal.

Dajao unmistakably were seen, but not captured, also in the Rio Capira at Campaña, and in the Rio Chiriquí Viejo, at an elevation of about 4,600 feet. The Rio Chiriquí Viejo, being rather far

removed (in western Panama) from the other points where we collected, it seemed especially desirable to obtain samples there for comparison with the ones from central Panama, but all efforts failed. Behre (1928, p. 312), whose specimens I have not seen, recorded this species from both slopes of western Panama without comment, indicating that she considered her specimens true *monticola*. During the earlier investigations (1911 and 1912) this species was taken in the Chagres Basin, in small streams at Porto Bello, and Toro Point, and on the Pacific side in almost every stream sampled in central Panama.

Dajao commonly inhabit rocky streams where seining is difficult, and they are as elusive as their salt-water relatives. They rarely take a hook. The species are valued as food, and reach a length of about 300 mm.

This fish occurs from sea level to mountain streams. According to the contents of stomachs of specimens taken in Puerto Rico it feeds on rather small organisms, such as insects, insect larvae, sponges, and apparently on algae. A specimen taken at Toro Point had ingested a small grasshopper.

This species is characterized by the rather slender, somewhat compressed body, which varies considerably in depth, being contained 3.2 to 4.1 in standard length; head 3 to 4.1; D. IV–I, 8; A. II (or III) 8 to 10; scales 38 to 43. The mouth is rather small, the maxillary reaching only to or a little beyond the anterior margin of the eye, 2.6 to 3.2 in head; eye 3.3 to 4.9; snout 3.1 to 4.3. The color is bluish black above, pale below, and in life yellowish along the sides, the brightness varying according to place of capture, those living in clear upland streams generally being more highly colored. The young sometimes have a dark lateral band, at least posteriorly, and a dark caudal spot seems to be present at all ages.

This species is recorded from Mexico, Central America, and the West Indies. Although it is common on both slopes of central Panama it has not been reported from eastern Panama, nor from Colombia.

Agonostomus macracanthus Regan.

Agonostomus macracanthus Regan, Ann.Mag. Nat. Hist., (7), **19**, p. 65, 1907 —Rio Guacalate, Guatemala; Meek and Hildebrand, Field Mus. Nat. Hist., Zool. Ser., **10**, p. 335, 1916.

No specimens of this apparently rare species were secured in 1935 and 1937. We reported in our earlier work only two specimens, which were taken in the Rio Indio, an upper tributary of the Chagres.

Behre (1928, p. 312) recorded four specimens from the Atlantic slope of extreme western Panama. It is not reported from eastern Panama, though Eigenmann (1922, p. 187) recorded two specimens from San Lorenzo, Colombia.

Its range, according to the literature at hand, extends from the Rio Guacalate (Pacific), Guatemala to San Lorenzo (Atlantic), Colombia.

Joturus pichardi Poey.

Joturus pichardi Poey, Memorias, 2, p. 263, 1860—Cascades throughout Cuba; Meek and Hildebrand, Field Mus. Nat. Hist., Zool. Ser., **10**, p. 336, 1916.

This fish is known from Panama only from the Chagres Basin. It lives at the base of waterfalls. It was not taken in 1935 nor 1937. The specimens reported by us (1916, p. 336) were caught at the foot of waterfalls on the Rio Indio, an upper tributary of the Chagres, and at the base of the Gatun "Spillway," an artificial falls.

This species is known from Cuba, and from Mexico to Panama.

Family CICHLIDAE. Mojarras

Five genera were included in our earlier (1916) work. One genus, *Herotilapia* (with one species) is now added on the basis of a record by Behre (1928) from western Panama. This genus is readily recognized by the compressed, incisor-like, tricuspid teeth. Its nearest relative in central Panama is *Neetroplus*, which has simple incisors in the jaws; that is, compressed teeth with even cutting edges.

Six species of the genus *Cichlasoma* were added to the fauna of Panama by Dr. Behre, in the paper already referred to, since the publication of our earlier work. Dr. Behre collected in extreme western Panama, which appears to be inhabited chiefly by Central American species. The specimens collected by Dr. Behre were not seen by me.

The common name for this family usually appearing in books is "mojarras." However, ichthyologists use the name "cichlids," derived from the generic name *Cichlasoma*. This term appears several times in the following pages.

Aequidens coeruleopunctatus (Kner and Steindachner). "CHOGORRO."

Acara coeruleopunctata Kner and Steindachner, Sitzber. Akad. Wiss., Munchen, p. 222, 1863—Rio Chagres, Isthmus of Panama.

Aequidens coeruleopunctata Meek and Hildebrand, Field Mus. Nat. Hist., Zool. Ser., **10**, p. 339, 1916.

This is one of the most generally distributed species in the waters of central and eastern Panama. Specimens were taken on the Atlantic side, in 1935 and 1937, in a creek below an abandoned reservoir at Gatun; in Gatun Lake at Gatun, Barro Colorado Island, and several places between Gamboa and Madden Dam; and in a creek tributary to Gatun Lake on Madden Dam Road. On the Pacific side it was secured in coastal streams between Campaña and La Venta, Rio Capira at Campaña, Rio Pacorá on the Chepo Road, La Jagua Hunting Club, Miraflores Lake, and in the Rio Cocoli. It was not present in the locks at either end of the Canal when they were dewatered in 1935 and 1937.

This species does not grow large enough to have much value as a food fish. The largest specimen at hand is only 145 mm. long, though one of 157 mm. has been reported. The average size is only about 100 mm. It is not as numerous in Gatun and Miraflores lakes as *Cichlasoma maculicauda*.

Breder (1927, p. 139) has reported that this fish, according to stomachs examined by him, feeds largely on insects, though a large amount of debris, including some plant tissue, was present. The three stomachs examined by me all contained fragments of insects. One contained a mass of crushed molluscan shells; two contained a few ostracods; and one definitely contained fragments of a plant. The pharyngeal teeth are well developed, in two large patches above and one below, and the individual teeth are rather blunt. The presence of this grinding apparatus, together with the fragmentary appearance of the foods ingested, suggests that a fair degree of mastication precedes swallowing.

This cichlid is easy to recognize in life, among its relatives in Panama, by the emerald green spots on the head and sides, and by two lines of the same color on the cheeks. These spots and lines generally remain visible in preserved specimens but become dusky. A more or less definite dark lateral band is generally present, with an intensely black blotch below the spinous dorsal, and frequently with a second but smaller black spot at the base of the caudal. The young lack the emerald green spots and lines mentioned, and are distinctly barred with black. These black bars often persist in adults and form saddle-like blotches on the back. The gill arches are normally formed, and the gill rakers are short and fleshy, more or less fan-shaped, and only seven or eight are more or less developed on the lower limb of the first arch. In adults the head is broad, and the interorbital greatly exceeds the diameter of the eye. The anal

fin consists of only 3 spines and 7 or 8 soft rays, and the dorsal has 14 or 15 spines and 9 to 11 soft rays. The scales are large, as there are only 26 or 27 in a lateral series and only 3 between the lateral line and the origin of the dorsal. The body is not as deep as in some of the other cichlids, as the depth is contained 2 to 2.3 times in the standard length.

Two of three specimens dissected were females with large roe. One of these was taken February 11 and the other April 2. The third specimen, a male, caught February 23, was undeveloped. Many young, ranging upward of 10 mm., apparently belonging to this species, were collected during February. The indications, therefore, are that spawning takes place during the dry season.

The range extends from central (both slopes) to eastern Panama and somewhat doubtfully into Colombia and northwestern Ecuador. In Colombia it seems to be replaced ehiefly by *A. latifrons*, which from a study of descriptions (no specimens being available) seems doubtfully distinct. *A. coeruleopunctatus* has not been recorded from western Panama.

Geophagus crassilabris Steindachner.

Geophagus crassilabris Steindachner, Sitzber. Akad. Wiss., Wien, 74, p. 65, pl. 7, 1876—vicinity of Candelaria, Isthmus of Panama; Meek and Hildebrand, Field Mus. Nat. Hist., Zool. Ser., **10**, p. 340, 1916.

This cichlid is rather common in the streams of both slopes of central Panama, and also in the Tuyra Basin, as shown by collections made by us in 1911 and 1912 and by Breder (1927, p. 139). In 1935 and 1937 it was taken only in Gatun Lake near Madden Dam, in a creek tributary to Gatun Lake on the Madden Dam Road, and in Miraflores Lake. This species is known to reach a length of at least 265 mm. Although it was taken in both Gatun and Miraflores lakes, it does not seem to be common, and probably cannot be considered available as a food and game fish.

This species is readily recognized by its long, pointed snout, which is much longer than the postorbital part of the head in adults, and proportionately much longer than in any other cichlid known from Panama. It differs from all other Panama species, furthermore, in the peculiar development of the upper part of the gill arch, which is provided with a fleshy growth, usually described as a lamelliform lobe. Adult males have a very prominent nuchal hump. This species has only 3 anal spines and 7 or 8 soft rays. Its dorsal fin consists of 16 spines and 9 or 10 soft rays. Most specimens have more or less definite crossbars, and the young also have a black

lateral band. A fresh specimen, about 175 mm. long, had the color as follows: Greenish above, slightly golden on the belly, with indications of dark broken crossbars on the sides, and a large black blotch on the side below the posterior part of the spinous dorsal. The large lips were dark blue, and the opercle bluish green to black. Individual scales on the side were bluish green. The pectorals were greenish, and all the other fins were pink to reddish.

The range seems to be limited to both slopes of central and eastern Panama. It has not been taken in western Panama. In Colombia it seems to be replaced by the closely related *G. pellegrini*.

Cichlasoma Swainson.

All the cichlids known to occur in Panama having conical, or somewhat compressed teeth, yet surmounted by conical apices (not incisor-like teeth), in combination with 5 or more anal spines, are herein included in the genus *Cichlasoma*. It seems advisable to present a key, because six species not included in our earlier publication (1916) have been added by the work of Behre (1928). Unfortunately, it has not been possible to examine Dr. Behre's collection, and no other specimens have been available to me for examination of *altifrons* or *lethrinus*. Therefore, it has been necessary to rely partly on published accounts for some of the characters used in the key.

KEY TO SPECIES OF CICHLASOMA

a. Teeth all conical or pointed, not notably or at all compressed; fold of lower lip continuous or interrupted.

b. Snout long, much longer than postorbital part of head; D. XVI, 11; A. V, 8 or 9; about 30 scales in lateral series; body with 5 or 6 dark crossbars; no lateral band . . . . *altifrons*.

bb. Snout shorter, little if any longer than postorbital part of head; dorsal usually with 17 or 18 spines; anal with 6 to 10 spines.

c. Lower lip broad, with a continuous free fold; body moderately to quite elongate, the depth about 2.2 to 3 in standard length.

d. Body quite elongate and robust, the depth about 2.5 to 3 in standard length; lower jaw projecting; anterior pair of teeth in upper jaw notably enlarged, canine-like; sides with a series of dark spots forming a more or less continuous lateral band; definite dark bars present only in young; D. XVII or XVIII, 10 or 12; A. VII, 8 to 10; scales 30 to 32, 5 or 6 rows between lateral line and origin of dorsal, but only 3 between lateral line and middle of base of dorsal. *motaguense*.

dd. Body rather deeper and more strongly compressed, the depth about 2.15 to 2.5 in standard length; lower jaw not reaching beyond the upper one; none of the teeth greatly enlarged or canine-like.

e. Snout long and rather pointed, equal to or somewhat longer than postorbital part of head; lateral line rather strongly arched, only 3 or 4 complete rows of scales between it and origin as well as middle of dorsal; sides with a large black blotch under middle of

base of dorsal, a smaller one on upper half of base of caudal; distinct crossbars and a lateral band present only in young. *calobrense.*

ee. Snout shorter, less pointed, a little shorter than postorbital part of head; lateral line less strongly arched, with 5 or 6 complete rows of scales between it and the origin as well as middle of dorsal; sides with a rather narrow, well-defined, continuous black lateral band; no crossbars except in very young. . . . . *umbriferum.*

cc. Lower lip narrower, the fold not continuous, being interrupted anteriorly; body deep to only moderately elongate.

f. Body very deep, the depth 1.75 to 2 in standard length.

g. Scales rather small, 34 to 40 in lateral series; lateral line at point of interruption reappearing on fifth row of scales below its original course; adults with a series of about six dark blotches along middle of side; young with dark crossbars; scales with dark dots, forming more or less definite rows . . . . *tuyrense.*

gg. Scales larger, 28 to 33 in lateral series; lateral line at point of interruption reappearing on third row of scales below its original course.

h. Scales large, 28 to 30 in lateral series, 2 or 3 complete rows between lateral line and middle of base of dorsal; D. XVIII or XIX, 9 or 10; A. VIII or IX, 7 or 8; sides with about 7 crossbars; no lateral band . . . . *spilurum.*

hh. Scales somewhat smaller, 31 to 33 in a lateral series, 5 or 6 complete rows between lateral line and middle of dorsal; D. XVII or XVIII, 11 or 12; A. VI, 9 or 10; no distinct bars and no lateral band, except in very young; a large black blotch at base of caudal . . . . *maculicauda.*

ff. Body moderately elongate, the depth about 2.3 to 2.6 in standard length.

i. Scales large, 29 to 31 in lateral series; D. XVII or XVIII, 10 to 12; pectoral nearly as long as head, reaching to first or second anal spine; sides with 6 dark crossbars, and a more or less continuous dark lateral band; sides of head not spotted . . . . *lethrinus.*

ii. Scales slightly smaller, 31 to 34 in lateral series; D. XVI to XVIII, 12 to 14; pectoral only about three-fourths length of head, not extending to origin of anal; sides often without bars, sometimes with blotches along lateral line; sides of head spotted. . *guttulatum.*

aa. Teeth more or less flattened, but with conical apices; fold of lower lip not continuous, being interrupted anteriorly.

j. Sides with about 9 dark crossbars, the first two bent forward across nape; no dark spots on scales; D. XVII to XIX, 8 or 9; A. VIII to X, 5 to 8; scales 27 to 30 . . . . *nigrofasciatum.*

jj. Sides with 5 or 6 more or less interrupted bars, forming a series of blotches above lateral line, and another series at or somewhat below middle of side; no bars on nape; scales and vertical fins with dark spots; D. XVII, 11; A. V, 8; scales 30 to 32 . . . . *sieboldii.*

Cichlasoma altifrons (Kner and Steindachner).

Heros altifrons Kner and Steindachner, Abhandl. Bayer. Akad. Wiss., München, **10**, p. 11, pl. 2, fig. 1, 1864—"New Granada."

This species was omitted from our earlier publication because of the uncertainty regarding the type locality. It is now included in the fauna of Panama, principally because specimens have been recorded from the Atlantic slope of extreme western Panama by Behre (1928, p. 321).

The type locality given for this species by Kner and Steindachner is "New Granada," or Colombia. However, Eigenmann (1922) did not record it from Colombia, and it has not been taken in eastern or central Panama by us or, according to the records available, by other collectors. If I interpret Günther (1868, p. 459) correctly, he indicated without qualification that the types came from Chiriquí, Pacific slope of western Panama. Regan (1908, p. 463) recorded it from the Rio Grande de Térraba (Pacific slope), Costa Rica. Meek (1914) did not take this species in Costa Rica, and it was not included in a collection from that country made by Dr. Anastasio Alfaro, reported upon by me (1930). The species may be rather rare and the distribution peculiar. According to the records, as already shown, the species occurs in Colombia, both slopes of western Panama and the Pacific slope of Costa Rica.

Head about 2.75; depth 2.3; D. XVI, 11; A.V, 8 or 9; scales 31 to 33.

Snout notably longer than postorbital part of head; eye 4 to 5 in head; mouth rather small, nearly terminal; maxillary not reaching eye; lips thick, the fold of the lower one split anteriorly; teeth conical, the outer and anterior ones scarcely enlarged; cheeks with 4 or 5 series of scales; dorsal spines graduated, the last one scarcely half the length of head; caudal rounded to more or less truncate; pectoral scarcely reaching origin of anal.

Color brownish; sides with 4 or 5 dark bars; body, and vertical fins exclusive of spinous parts, spotted (condensed after Kner and Steindachner).

Cichlasoma motaguense (Günther).

Heros motaguense Günther, Trans. Zool. Soc. Lond., **6**, p. 462, pl. 77, fig. 3, 1868—Rio Motagua, Guatemala.

This cichlid is included in the Panama fauna on the basis of specimens recorded by Behre (1928, p. 320), collected in the Atlantic drainage of extreme western Panama.

Head 2.35 to 2.8; depth 2.2 to 3; D. XVII to XIX, 10 to 12; A. VII or VIII, 8 to 10; scales 30 to 32.

Body rather elongate and robust; caudal peduncle short; its depth 2.55 to 3 in head; snout nearly as long as postorbital part of head, 2.4 to 2.7; eye 3.25 to 6.1; mouth moderately large, oblique, lower jaw projecting, maxillary nearly reaching eye; lower lip with an uninterrupted fold; teeth conical, the anterior pair in upper jaw enlarged, canine-like; 5 or 6 rows of scales between lateral line and

origin of dorsal; about 8 series on cheek; dorsal spines graduated, the last one scarcely a third the length of head, caudal broadly rounded; pectoral fins reaching scarcely to tip of ventrals and not quite to origin of anal, 1.5 to 1.7 in head.

Color dark green to bluish above, more or less silvery underneath. Sides with dark blotches, forming an interrupted lateral band. Young with crossbars and a more pronounced lateral band. Body and head, except snout, with rusty spots, which are present also on the vertical fins (described from specimens collected in El Salvador).

The range apparently extends from British Honduras (Belize), the Rio Motagua, Guatemala, to the Atlantic slope of western Panama, though it does not seem to have been recorded from intermediate localities. On the Pacific slope it has been recorded from several lakes in El Salvador (including Lake Guija, which is partly in Guatemala).

Cichlasoma calobrense Meek and Hildebrand.

Cichlasoma calobrense Meek and Hildebrand, Field Mus. Nat. Hist., Zool. Ser., **10**, p. 90, 1913—Rio Calobre, Panama; p. 346, pl. 29, 1916.

This cichlid is recorded from the Bayano and Tuyra basins in our earlier work (1916, p. 346), the type being from the Rio Calobre, a tributary of the Bayano. Breder (1927, p. 140) reported it from the Chucunaque Basin from near Yavisa. Although the species has not been taken in the vicinity of the Canal Zone, and never before in the Atlantic drainage, Behre (1928, p. 322) recorded it from the Atlantic slope on both sides of the Panama–Costa Rica border.

Cichlasoma umbriferum Meek and Hildebrand.

Cichlasoma umbriferum Meek and Hildebrand, Field Mus. Nat. Hist., Zool. Ser., **10**, p. 88, 1913—Rio Cupe, Cituro, Panama; p. 347, pl. 30, 1916.

This species was reported from the Rio Tuyra by us (1916, p. 347), the type being from the Rio Cupe, one of the larger tributaries. Breder (1927, p. 140) found it common in the Rio Sucubtí, an upper tributary of the Rio Chucunaque, where he took specimens up to 340 mm. in length, which are much larger than any seen by us.

Eigenmann (1922, p. 207) reported this cichlid from the "Chepo, Tuyra, Atrato, and Magdalena basins." We have no record of its occurrence in the Chepo River and believe that "Chepo" was included by mistake. Therefore, its habitat, so far as known to date, is restricted to the Tuyra, Atrato, and Magdalena basins.

Cichlasoma tuyrense Meek and Hildebrand.

Cichlasoma tuyrense Meek and Hildebrand, Field Mus. Nat. Hist., Zool. Ser., **10**, p. 89, 1913—Rio Tuyra, Boca de Cupe, Panama; p. 344, pl. 28, 1916.

This species, reported from the Bayano and Tuyra basins in our earlier work (1916, p. 344), has since been reported (Breder, 1927, p. 140), also from the Rio Chucunaque, a large tributary of the Tuyra not visited by us. It is not reported from the Canal Zone and westward.

Cichlasoma spilurum (Günther).

Heros spilurus Günther, Cat. Fish. Brit. Mus., **4**, p. 289, 1862—Lake Yzabál, Guatemala.

This fish is included here because of a record by Behre (1928, p. 321), who took it in the Atlantic drainage of extreme western Panama. Dr. Behre remarked: "This species has hitherto been described no farther south than the Atlantic slope of Guatemala, La Yzabál and Rio Motagua, except in the Canal Zone. It is strange that we should have found no examples from any except the southern limit of our territory. The only Canal Zone specimen available for comparison has been injured anteriorly so seriously as to invalidate measurements." I know of no Canal Zone record, other than this one by Dr. Behre, and have never taken a specimen there. If Dr. Behre's record is based solely on the injured specimen mentioned it may be that the identification is not reliable. In making the remarks quoted, Dr. Behre apparently overlooked the records by Meek (1914, p. 126) who took this species in Costa Rica in both the Atlantic and Pacific drainages.

Head 3; depth 2; D. XVIII or XIX, 9 or 10; A. VIII to X, 7 or 8; scales 28 to 30.

Snout as long as or somewhat longer than postorbital part of head, eye 3 to 4 times in head; mouth very small, terminal, the maxillary not nearly reaching the eye; fold of lower lip interrupted anteriorly; teeth in jaws pointed, the outer ones somewhat enlarged; 2 to 2½ rows of scales between lateral line and beginning of soft dorsal, 4 or 5 series on cheek; last dorsal spine 1.8 to 2 in head; caudal rounded or subtruncate; pectoral as long as or longer than head, reaching third to fifth anal spine, 1.15 in head.

Color olive green with 7 to 9 dark vertical bars; a large black spot or vertical bar at base of caudal; vertical fins dusky, sometimes spotted. Although the description was compiled from published accounts, the characters were checked from specimens in the United States National Museum, collected in Guatemala.

The range probably extends from Guatemala to western Panama.

Cichlasoma maculicauda Regan. "CHOGORRO."

Cichlasoma maculicauda Regan, Ann. Mag. Nat. Hist., (7), **16**, p. 227, 1905—Lake Yzabál and Rio Motagua, Guatemala, Rio Chagres, Panama; Meek and Hildebrand, Field Mus. Nat. Hist., Zool. Ser., **10**, p. 343, 1916.

Heretofore this species has been recorded in Panama only from the lower part of the Chagres Basin. In 1935 and 1937 it was taken on the Pacific side of the divide on the Canal Zone, namely, in Pedro Miguel Locks, Miraflores Lake, and in the upper chamber of Miraflores Locks. These places it apparently has reached by migrating through Culebra Cut. On the Atlantic side it was secured in Gatun Lake at Barro Colorado Island, at several places between Gamboa and Madden Dam; and also in the uppermost chamber of Gatun Locks. This fish seems to be fairly common both in Gatun and Miraflores lakes, as numerous specimens were taken.

This cichlid resembles the bluegill sunfish (*Lepomis incisor*), in the general shape of the body, in size, and somewhat in color. It is believed, therefore, that those few American residents of the Canal Zone who have reported the successful introduction of the bluegill sunfish (planted in Gatun Lake two or three different times, some years ago) have mistaken this cichlid for that sunfish, which apparently failed to become established. Its qualities as a food fish were not sampled by me, though an American at Pedro Miguel, who believed the fish to be the bluegill, said it was a good pan fish.

I could learn nothing of the game qualities of this cichlid from the local residents, and did not take the time to learn something about them at first hand. The fish, no doubt, is chiefly carnivorous, as shown by its teeth, the short alimentary canal, and the contents of the five stomachs examined. The principal food appears to consist of small mollusks. One specimen contained a great mass of debris, which apparently was in part plant tissue. Its prominent pharyngeal teeth are apparently well adapted to crushing shells. As this fish has a small mouth, small hooks would be necessary, and the bait apparently should consist of a small animal or of meat. Since the fish appears to be a bottom feeder, it should be fished for at or near the bottom. Because of its abundance, this species, if it can be induced to take the hook, apparently would be the most promising as a game fish of any indigenous species in the artificial lakes of the Canal. It grows sufficiently large to have value as a food fish, as many examples ranging from 250 to 320 mm. in length were taken.

This fish is readily recognized among Panama species by the deep body, the depth being contained in the standard length about

1.8 to 2.1 times; by the large scales, there being only 31 to 33 in a lateral series; and by the large black blotch on the peduncle at the base of the caudal. Frequently a second black blotch appears on the side below the posterior half of the spinous part of the dorsal. Very young have a dark lateral band, but distinct dark bars are wanting. The dorsal is composed of 17 (sometimes 16 or 18) spines and 11 to 13 soft rays; and the anal of 6 spines and 9 (sometimes 8 or 10) soft rays.

Five fish, taken in February, were dissected. One female contained large roe, indicating that spawning probably takes place during the dry season. Males do not develop a very prominent nuchal hump, as in some of the other species of this family.

The natural range as now understood extends from British Honduras (Belize) to Panama on the Atlantic slope. The occurrence in Miraflores Lake, herein reported, apparently is the result of migration from the Atlantic to the Pacific slope through Culebra Cut. It is to be remarked that *C. maculicauda* was not contained in a rather large collection from Costa Rica, reported upon by Meek (1914); neither was it included in collections from that country studied by the writer (1930); and Behre (1928), who collected extensively on the Atlantic slope of both sides of the Panama-Costa Rica border, failed to get it. It is strange, therefore, that this species is unreported, except for a record by Fowler (1916, p. 399), without comment, from Port Limón, Costa Rica, in the territory between the Canal Zone and the Motagua Basin, Guatemala. It is possible that upon comparison of specimens from the Chagres and the Motagua basins, which is not possible for me at this time, it may be found that the fish from the two river systems are not identical, though no differences are evident from published descriptions.

Cichlasoma lethrinus Regan.

Cichlasoma lethrinus Regan, Ann. Mag. Nat. Hist., (8), 2, p. 462, 1908—Rio Iroquois, Costa Rica.

This species was taken by Behre (1928, p. 322) in streams of the Atlantic drainage on both sides of the Panama-Costa Rica border. It has been recorded from both slopes of Costa Rica (Meek, 1914, p. 126).

Head 2.66 to 3; depth 2.33; D. XVII or XVIII, 10 to 12; A. VI or VII, 8 to 10; scales 29 to 31.

Snout equal to or a little longer than postorbital part of head; eye 3.5 to 4.5 in head; mouth terminal; maxillary not extending to eye; fold of lower lip interrupted anteriorly; teeth in outer series in

both jaws somewhat enlarged anteriorly, gradually decreasing in size laterally; 2½ rows of scales between lateral line and beginning of soft part of dorsal, 4 to 4½ at origin of dorsal, 5 series on cheek; dorsal spines subequal from fifth to fifteenth, the last about 3 in head; caudal rounded; pectoral not much shorter than head, extending to above first or second anal spine.

Body with 6 dark crossbars, the first two broad and more or less confluent; a more or less continuous blackish longitudinal band from the eye to a spot on the upper part of the base of the caudal; vertical fins dusky, the soft dorsal and caudal with series of pale spots (condensed after Regan's original description).

Known from both slopes of Costa Rica and from the Atlantic slope of extreme western Panama.

Cichlasoma guttulatum (Günther).

Heros guttulatus Günther, Proc. Zool. Soc. Lond., **1864**, p. 152; Trans. Zool. Soc. Lond., **6**, p. 466, pl. 78, fig. 3, 1868—Lake Amatitlán, Guatemala.

This species, as well as several other cichlids, is included here in the fauna of Panama on the basis of specimens reported from the Atlantic slope of extreme western Panama by Behre (1928, p. 321). So far as I am aware it has not been reported from localities between Lake Amatitlán, Guatemala, and the Atlantic slope of far western Panama.

Head 2.8 to 3.4; depth 2.25 to 2.6; D. XVI to XVIII, 12 to 14; A. VI or VII, 9 or 10; scales 31 to 34.

Snout nearly as long as, or in large examples somewhat longer than, postorbital part of head; eye 3 to 4.65 in head; mouth rather small, nearly terminal; maxillary not reaching eye; fold of lower lip interrupted anteriorly; teeth conical, the anterior ones somewhat enlarged; 5 series of scales on cheek, 3½ to 4½ between lateral line and beginning of soft part of dorsal; the last dorsal spine about 4 in head; caudal subtruncate or rounded; pectoral not reaching origin of anal, 1.33 in head.

Color brownish; a broad dark band extending from above pectoral to base of caudal, this band sometimes interrupted, forming blotches; some specimens with 5 or 6 crossbars; sides of head and body, as well as the vertical fins, often spotted. (Though the description was compiled from published accounts, the characters were checked from specimens in the National Museum, taken in Lake Amatitlán, Guatemala.)

The range apparently extends from southern Mexico (Rio de Sarabia) to the Atlantic slope of extreme western Panama.

Cichlasoma nigrofasciatum (Günther).

Heros nigrofasciatus Günther, Trans. Zool. Soc. Lond., 6, p. 452, pl. 74, fig. 3, 1868—lakes Atitlán and Amatitlán.

This species was recorded from the Atlantic drainage from both sides of the Panama-Costa Rica border by Behre (1928, p. 323). It has been reported also from lakes Atitlán and Amatitlán (type localities) in Guatemala, from several lakes and streams in El Salvador, and from some rivers of the Pacific slope of Costa Rica.

Head 2.55 to 3.35; depth 1.9 to 2.25; D. XVII to XIX, 8 or 9; A. VIII to X, 5 to 8; scales 27 to 30; vertebrae 13+15.

Body compressed, short and deep; caudal peduncle short and deep, its depth 1.7 to 2.5 in head; snout shorter than postorbital part of head, 2.4 to 3.3 in head; eye 3.2 to 4.6; mouth small, terminal; maxillary failing to reach eye, 3.25 to 4.15 in head; fold of lower lip interrupted anteriorly; outer series of teeth in jaws somewhat enlarged and compressed, but with conical apices; 4 or 5 rows of scales on cheek, 4 complete rows between lateral line and origin of dorsal; dorsal spines graduated, the last one equal to postorbital part of head; caudal fin broadly rounded; pectoral reaching to or beyond origin of anal, 1.05 to 1.4 in head.

Color grayish green above, pale pinkish with silvery reflections below. Sides with 9 black bars, the first and second bent forward across nape, the second often meeting the third one on middle of side to form a V. Fins all dusky to black (description based on specimens from El Salvador and the Pacific slope of Costa Rica).

This species has been placed by some authors under *Paraneetroplus*, a genus based principally on the shape of the outer teeth in the jaws, which are described as somewhat flattened, but with rounded and pointed apices. Others have questioned the validity of this character, because of variation in the shape of the teeth. That considerable variation in dentition may occur within one species was pointed out by Meek (1914, p. 124) and by the present writer (1930, p. 8). Because of these variations this species is placed in the genus *Cichlasoma* herein, as in our earlier work.

This species ranges from lakes Atitlán and Amatitlán, Guatemala, to the Atlantic slope of extreme western Panama.

Cichlasoma sieboldii (Kner and Steindachner).

Heros sieboldii Kner and Steindachner, Abhandl. Bayer. Akad. Wiss., München, 10, p. 13, pl. 2, fig. 2, 1864—New Granada and the west slope of the Isthmus of Panama; Meek and Hildebrand, Field Mus. Nat. Hist., Zool. Ser., 10, p. 345, 1916.

This species was included in our earlier publication (1916, p. 345), because the original describers gave as type localities "New Granada" and the "west slope of the Isthmus of Panama." No streams or definite localities were named as places of capture of the 11 specimens, 125 to 200 mm. long, described. This cichlid was not reported from Colombia by Eigenmann (1922), and it apparently has not been seen in Panama since the record by Kner and Steindachner, unless the specimens reported under the name *Paraneetroplus sieboldii* by Behre (1928, p. 323) from the Rio Chiriquí del Tire (Pacific slope of western Panama) are the same. The identity is questioned by Dr. Behre, for she stated: "Our specimens are probably the same fish as *P. sieboldii* from Costa Rica, Regan, not *C. sieboldii* from Panama." It is not clear just what the writer had in mind. Regan (1907, p. 30) described *Herichthys underwoodi* from Costa Rica, which he later in the same publication (p. 186) synonymized with *H. sieboldii* Kner and Steindacher. If Dr. Behre meant to say that Regan's *sieboldii* from Costa Rica is different from *Heros sieboldii* Kner and Steindachner, then her specimens should stand as *C. underwoodi* (Regan). Meek (1914, p. 127), in fact, so recognized his specimens from Costa Rica.

I have examined a specimen in the National Museum (No. 102273) from the Quebrada de India, one of the tributaries of the Rio Coto (Pacific slope), Costa Rica, which agrees in seemingly all important characters with the description and figure of *C. sieboldi* (Kner and Steindachner). I am inclined therefore to follow Regan (1908, p. 186) in assuming that the Costa Rican material is identical with that described and figured by Kner and Steindachner.

The following proportions and counts are based on the Costa Rica specimen examined, which is 130 mm. long (standard length 102 mm.): Head 3; depth 2.5; D. XVII, 11; A. V, 8; scales 30. Snout scarcely longer than postorbital part of head, 2.25 in head; eye 4.25; interorbital 2.6; maxillary 3.8; caudal peduncle (depth) 2.25; longest dorsal spine 3.4; longest anal spine 2.8; pectoral 1.35. The outer teeth in both jaws are wide at the base, but the tips are pointed. The lateral line, at the point of interruption, begins again on the third row of scales below its original course. A slight indication of a dark lateral band is present; also a small caudal spot; on the upper half of the sides are dark blotches suggesting crossbars. The membranes of the dorsal and anal bear distinct black spots, which are indefinite on the caudal fin, and missing on the paired fins.

If the types of *C. sieboldii* (Kner and Steindachner) actually were collected in New Granada and on the west slope of the Isthmus of

Panama, it seems strange that this species was not taken there in the rather extensive collecting done in these regions since the beginning of the present century.

This species, as already stated, is too imperfectly understood to state its range definitely. According to records it apparently occurs from Costa Rica to Colombia.

Neetroplus panamensis Meek and Hildebrand.

Neetroplus panamensis Meek and Hildebrand, Field Mus. Nat. Hist., Zool. Ser., **10**, p. 90, 1913—Rio Mandingo, Bas Obispo, Canal Zone; p. 348, pl. 31, 1916.

This species was taken by us in several places in the Chagres Basin in 1911 and 1912. During the recent investigation it was found only in a creek, tributary to Gatun Lake, on Madden Dam Road where 11 specimens ranging in length from 38 to 95 mm. were seined. To date no evidence has been found indicating that this fish has established itself in the artificial lakes of the Canal. It apparently does not grow large, as no specimen more than 103 mm. long has been recorded.

This species differs from the others of the family known from Panama in having the anterior teeth in each jaw flattened, that is, more or less incisor-like, and with unindented cutting edges. The anal fin consists of 6, rarely 7, spines and 7 soft rays, and the dorsal has 17 or 18 spines and 9 or 10 soft rays.

The young have rather definite dark crossbars. The one lying under about the twelfth and thirteenth spines is broadened toward the middle of the side and intensely black, and a black caudal spot is present. In adults the bars fade and sometimes disappear, but the black blotch on the side, and generally the caudal spot, remain. Frequently other dark blotches are present on the side in adults. The following remarks concerning color are based on a fresh specimen 95 mm. long: General color dark olivaceous above, pinkish below. Many scales on sides with pearly spots, which are present also on the vertical fins.

This species had been reported only from the Chagres Basin until Breder (1927, p. 140) reported it somewhat doubtfully from a single specimen, 82 mm. long, from the Rio Chucunaque, in eastern Panama. Mr. J. T. Nichols of the American Museum of Natural History has kindly sent me Mr. Breder's specimen for study. After comparing it with Chagres River specimens I am convinced that it is a true *N. panamansis*. The scale and fin-ray counts agree perfectly, and the proportions come well within the range of Chagres River

specimens. Although the color markings on the sides of this specimen, which is presumably a male, are not as distinct as in some males from the Chagres, they are similarly placed. In general, the dark color markings are less distinct in males than in females, but males have pale spots (probably pearly in life) on the soft dorsal and less distinctly on the caudal, which the females do not possess. These markings on the fins are rather more distinct on the Chucunaque specimen than on any Chagres River fish at hand.

This species is known from the Chagres Basin, where it is common, and from a single specimen from the Tuyra Basin.

Herotilapia Pellegrin.

This genus differs from *Neetroplus* only in having the compressed, incisor-like teeth tricuspid instead of having a continuous cutting edge. This genus is not included in our earlier (1916) work.

Herotilapia multispinosa (Günther).

Heros multispinosus Günther, Trans. Zool. Soc. Lond., 6, p. 453, pl. 74, fig. 2, 1868—Lake Managua, Nicaragua.

This species is included in the Panama fauna on the basis of a record by Behre (1928, p. 324) who collected specimens (not seen by me) in the Atlantic drainage on both sides of the Panama-Costa Rica border.

This cichlid is readily distinguished from other species in Panama by its tricuspid incisor-like teeth, a character recognized as of generic importance. The dorsal consists of 18 spines and 9 soft rays, and the anal of 11 spines and 7 or 8 soft rays. The scales are large, only 28 or 29 being present in a lateral series. The color is brownish olive, each scale being somewhat darkened at the base. A blackish lateral band extends from the eye to the base of the caudal, but is more or less broken posteriorly by dark blotches, indicative of bars, with a definite black blotch on the side below the posterior half of the spinous part of the dorsal.

The range apparently extends from Nicaragua (Lake Managua) to the Atlantic slope of extreme western Panama, the species being recorded only from the type locality, Lake Managua, and from the Atlantic drainage from both sides of the Panama-Costa Rica border.

Family GOBIIDAE. Gobies

The family Gobiidae, as formerly understood, has been divided by some recent authors who recognized those forms that have the ventral fins separate, that is, not united to form a sucking disk, as

a distinct family under the name Eleotridae. The present writer has no fault to find with this division, though he has found remarkable similarity in the appearance and development of the young. For convenience the species from the fresh waters of Panama are treated here as one family, as in the earlier work by Meek and Hildebrand (1916). Only two genera, *Awaous* and *Sicydium*, with united ventrals are included.

The fresh and brackish water gobies (Eleotridae) are more numerous as to species in Panama than elsewhere. Thirteen species with separate ventrals are recognized in the following pages. None is common to both slopes (except the few that have recently "crossed over" through the Canal), though five species of each slope have extremely close relatives on the opposite sides, leaving only two on the Atlantic and one on the Pacific slope without near relatives. Contrary to the other fresh-water families of Panama, this group seems to have its center of distribution on the Isthmus of Panama.

Gobiomorus Lacépède. GUAVINA.

Gobiomorus has replaced *Philypnus*, long used for this genus, on the basis of priority.

Only two species of this genus, both occurring in Panama, are known. They are rather sluggish carnivorous fishes, generally occupying shallow weedy areas where they lie quietly, hiding more or less among the plants, from which they make quick excursions, if hunger prompts them, to seize almost any animal of suitable size that comes near.

Although the species reach a sufficiently large size they do not seem to find much favor as food fishes.

Gobiomorus dormitor Lacépède.

Gobiomorus dormitor Lacépède, Hist. Nat. Poiss., **2**, p. 599, 1798—Martinique, from a drawing by Plumier.

Philypnus dormitor Meek and Hildebrand, Field Mus. Nat. Hist., Zool. Ser., **10**, p. 350, 1916.

Thirty specimens of this species, ranging in length from 35 to 185 mm., were preserved, and others were examined in the field. These specimens were collected at Cativa, and in Gatun Lake at Gatun, Barro Colorado Island, and a short distance below Madden Dam.

As this species and its Pacific slope congener, *maculatus*, were common in the waters of the Canal Zone before the opening of the Canal, according to investigations made in 1911 and 1912, crossing

over through Culebra Cut, and intermingling of the species would be expected. Although *maculatus* has entered Gatun Lake, as shown in the discussion of that species, no evidence indicating that *dormitor* has crossed over to Miraflores Lake and adjacent waters was gained.

This species is rather close to *maculatus*, yet the two are readily separable by the differences in the scale and anal fin formulae, and color. In 20 specimens of *dormitor* 19 have I, 9 anal rays and one has I, 10, whereas in 23 specimens of *maculatus*, 21 have I, 10 rays and one has I, 11, the last partly divided ray having always been counted as one. In the same specimens the number of oblique series of scales between the upper anterior angle of the gill opening and the base of the caudal ranges from 62 to 66, and the complete longitudinal rows between the bases of the second dorsal and anal from 19 to 22 in *dormitor*, and 55 to 60 and 17 or 18, respectively, in *maculatus*. In color, *dormitor* differs principally in having much larger and more prominent dark spots on the dorsal, caudal, and pectoral fins. Generally the dark lateral band is much more prominent in *dormitor*, and it persists more or less in large specimens, whereas it is not evident in the larger specimens of *maculatus*, nor even in some of the young.

This fish reaches a length of about 325 to 375 mm. Although used as a food to a limited extent, it is not valued highly.

This species ranges from Texas to Brazil and the West Indies. It is common in brackish and fresh-water lowland swamps and streams, and it also ascends rivers in which it occupies shallow weedy coves. It has been taken in all suitable localities on the Atlantic slope of Panama where collections have been made. Behre (1928, p. 311) recorded it from extreme western Panama, from the province of Bocas del Toro.

Gobiomorus maculatus (Günther).

Lembus maculatus Günther, Cat. Fish. Brit. Mus., 1, p. 505, 1859—Andes of Ecuador.

Philypnus maculatus Meek and Hildebrand, Field Mus. Nat. Hist., Zool. Ser., **10**, p. 352, 1916.

Thirty-one specimens, ranging in length from 40 to 210 mm., were preserved, and others were examined in the field. The specimens were collected in Gatun Lake, Miraflores Lake, Rio Cocoli, Pedro Miguel Locks, upper and lower chambers of Miraflores Locks, Rio Cabra, and in some small coastal streams crossing the National Highway between Campaña and La Venta.

As noted in the preceding paragraph, the species was taken in Gatun Lake, the catch consisting of two specimens, 127 and 210 mm. long, caught in the lake only a short distance below Madden Dam. These two specimens are typical *maculatus*, that is, they appear to be identical with specimens from streams of the Pacific slope of Panama not connected with the Canal. Although the two species must be living together, as shown by three specimens of *dormitor* and two of *maculatus*, taken together in one cove of Gatun Lake, no indication of cross-breeding is evident. However, a specimen, 147 mm. long, from Barro Colorado Island has some of the characters of both species, but it also differs from both. It agrees with *dormitor* in the scale formula (64–22), and in color; it agrees with *maculatus* in the anal fin formula (I, 10); but it differs from both in the more slender body (depth 6.6, and peduncle 11.6 in standard length), in the larger eye (5.25 in head, compared with about 6 to 6.5 in other specimens of about equal length), and in having one more spine and one more ray in the dorsal fins, the formula being VII–I, 10. In the absence of similar specimens, supplying more evidence of cross-breeding, or that a third species is present, the specimen is regarded, for the present, as a variant *dormitor*.

This fish apparently reaches a length about equal to that of *dormitor*, the largest individual seen being 325 mm. long.

The range of this species extends from Lower California to Ecuador. It lives in environments similar to *dormitor* and seems to be identical with that species in its behavior and selection of food.

Dormitator Gill. GUAVINA.

Two very closely related species from the opposite slopes of Panama are recognized. The relationship, which is discussed in the following accounts, is so close, however, that the species must be regarded as doubtfully distinct.

The common name, guavina, seems to be widely used in Central America and the West Indies for the species of this genus and for those of related genera.

Dormitator maculatus (Bloch).

Sciaena maculatus Bloch., Naturgesch. Ausland., Fische, pl. 299, fig. 2, 1790—West Indies.

Dormitator maculatus Meek and Hildebrand, Field Mus. Nat. Hist., Zool. Ser., **10**, p. 354, 1916.

Specimens of this species were taken at Fort Sherman (Toro Point), and at Cativa, on the Atlantic side. In addition 15 small

specimens, ranging in length from 20 to 85 mm., taken in the lower flight (east side) of Miraflores Locks, seem to be of this species. If the last-mentioned specimens are correctly identified, it would appear that a migration from the Atlantic to the Pacific side, through the Canal, had taken place. The Pacific drainage representative of the genus, namely, *latifrons*, was not taken in the Miraflores Locks when they were dewatered, but was secured there later. The relationship between the two species, as shown subsequently, is so close that too much reliance must not be placed on the identification of juveniles. Other specimens taken in the Pacific drainage certainly are separable from the Atlantic ones, and are in entire agreement with the differences stated by Meek and Hildebrand (1916, pp. 353–356), based on a study of specimens collected in 1911 and 1912.

This species apparently differs from *latifrons* chiefly in having somewhat fewer scales, and rather longer pectoral and ventral fins, as shown in the counts and measurements given subsequently. Furthermore, the mouth seems to be a little more strongly oblique in *maculatus* than in *latifrons*, as the cleft anteriorly is generally well above the lower margin of the eye, whereas in the latter it is usually about at the level of the lower margin of the eye.

The following measurements and counts are based on seven small specimens ranging in length from 45 to 85 mm., no larger specimens of this species having been secured during the recent investigation: Head 3.2 to 3.4; depth 3.7 to 4; D. VII–I, 8 (if the last partly separated ray is counted as 1); A. I, 8 or 9; P. 14; scales 30 to 33, 7 to 9 complete longitudinal rows between the base of dorsal and anal. Snout 3.3 to 4 in head; eye 4 to 4.7; interorbital 2.5 to 3.2; maxillary 3.3 to 3.5. Pectoral 1.1 to 1.5 in head, 3.7 to 4.1 in standard length; ventral 1 to 1.2 in head, 3.4 to 3.9 in standard length.

This species, like its Pacific slope relative, lives in still, brackish and fresh water, often being found in very shallow warm stagnant pools and coves, where it feeds on algae and other plants. Although primarily a vegetarian in nature, this species and its relatives have been used very successfully in South America for the control of mosquito-breeding in water containers. When plants are not present they feed on wiggle-tails; they live well in confinement; and are too sluggish (or sleepy, as the generic name indicates) to jump out of even a brimful container, a difficulty experienced with the top minnows, which in nature are far better for mosquito control. It must not be assumed that these guavinas are useful in nature for

mosquito control, because they feed on wiggle-tails when confined in comparatively small containers wherein algae and other plants, which constitute their usual food, are absent. Apparently in the absence of the usual diet they take what is available and exist on it.

This fish as now understood ranges on the Atlantic slope from North Carolina to Para, Brazil, and the West Indies. During the earlier investigations in Panama (1911 and 1912) it was taken in many lowland brackish ponds and streams from Porto Bello to Toro Point, and Behre (1928, p. 310) recorded it from extreme western Panama from the province of Bocas del Toro.

Dormitator latifrons (Richardson).

Eleotris latifrons Richardson, Voyage "Sulphur," Fishes, p. 57, pl. 35, figs. 4, 5, 1837—probably Pacific coast of Central America.

Dormitator latifrons Meek and Hildebrand, Field Mus. Nat. Hist., Zool. Ser., **10**, p. 355, 1916.

Specimens were taken only in a stagnant pool, wherein they were numerous, in a creek near the head of tide on the National Highway near Campaña, during the recent investigations. Later specimens, taken in Miraflores Locks by Mr. Lear, a Locks employee, were received. *D. latifrons* seems to be rather common along the Pacific coast of Panama in habitats similar to the first one mentioned above, as it was taken in several such places during the earlier (1911 and 1912) investigations. Meek and Hildebrand did not see it in the Tuyra Basin, but Breder (1927, p. 141) took specimens in a stagnant tidal pool near Yavisa in that river basin.

The relationship between this species and *maculatus*, as stated in the account of the last-mentioned species, is very close. The following measurements and counts, based on six specimens ranging in length from 47 to 205 mm., are useful in showing the minor differences.

Head 2.75 to 3.1; depth 2.8 to 3.2; D. VII–I, 8 (if the last partly divided ray is counted as one); A. I, 9; P. 14 or 15; scales 34 to 36, 10 to 12 complete longitudinal rows between the base of dorsal and anal. Snout 3.1 to 3.8 in head; eye 4.8 to 7; interorbital 2.1 to 2.75; maxillary 3.1 to 3.5. Pectoral 1.25 to 1.4 in head, 3.5 to 3.9 in standard length; ventral 1.4 to 1.8 in head, 4.3 to 4.7 in standard length.

The bright or even brilliant color of the fish taken March 11, 1937, from a very stagnant dirty pool, was striking by contrast. Bright colors had not previously been noticed by me in other specimens, and they may be nuptial, as the brightly colored speci-

mens were developing males. Specimens taken later (September 30, 1937) in Miraflores Locks, by Mr. Lear, upon which Dr. Foster based color notes, also were brightly colored. The specimens taken by Mr. Lear were schooling in the locks. Dissections made by Dr. Foster and by me show that the fish forming the schools were in spawning condition. Therefore, the fish apparently schooled to carry out their reproduction activities. That this was taking place in the locks is interesting. Spawning, then, would appear to take place during the rainy season—our summer.

The following notes on color were based on a male 200 mm. long, immediately after the fish was caught. Brownish above in advance of dorsal, bluish on sides with indications of lighter crossbars; belly pale gray; head bluish underneath. Many scales on side have a brownish base. Dorsal fin brownish with dark markings and a brilliantly red margin; caudal fin similar in color, but without spots; anal fin green at base, with dark spots, and the outer two-thirds bright red; ventrals bluish green; pectorals wholly pinkish; iris red. That there is variation even among adults is evident from notes taken by Dr. Foster, based on a fish (sex not stated) taken in Miraflores Locks to which reference was made in the preceding paragraph. The following description is condensed after Dr. Foster:

Body blue-green dorsally to inconspicuously greenish red ventrally. Head slate-colored; iris red. Dorsal fin gray with black polka dots and inconspicuous red margins; caudal fin gray; anal fin deep maroon, with 2 or 3 rows of blue polka dots near and parallel to body, the margin conspicuously white; pectorals and ventrals blue-gray.

This fish ranges from Lower California to Ecuador.

Eleotris Bloch and Schneider. GUAVINA.

Three species of this genus occur in Panama. They are highly carnivorous, and although a sufficiently large size is attained (at least by *picta*) they are not valued as food, possibly because they are covered with a heavy coat of mucus, which gives them a disagreeably slimy appearance.

The species are distinguished principally by the differences in the size of the scales, their degree of embedding, and by color, as pointed out in the following accounts.

Eleotris picta Kner and Steindachner.

Eleotris picta Kner and Steindachner, Abhandl. Bayer. Akad. Wiss., München, **10**, p. 18, pl. 3, fig. 1, 1864—Rio Bayano, Panama; Meek and Hildebrand, Field Mus. Nat. Hist., Zool. Ser., **10**, p. 357, 1916.

Thirty-one specimens, ranging in length from 22 to 480 mm., taken in Pedro Miguel and Miraflores Locks, Miraflores Lake, and in streams crossing the National Highway between Campaña and La Venta, were preserved. Many others were seen and examined. The largest individual seen was a male 495 mm. long, which may be near the maximum size attained. The indication is that this species grows larger than its near relative of the Atlantic slope, the largest specimen of that species seen being only 150 mm. long. In addition, 21 juveniles, ranging in length from 18 to 20 mm., were taken in the lower chamber (west side) of Miraflores Locks, in strongly brackish to salt water. None of these juveniles have the generically distinctive preopercular spine developed. However, it seems evident that the gill openings do not extend forward under the eyes, as in *Gobiomorus*, which has a similar fin ray count, and the mouth is large with protruding lower jaw. The young, therefore, seem to belong to *Eleotris*. Although the fins are quite fully developed, general pigmentation has not taken place. In general, the development is more retarded than in *Eleotris pisonis* and *E. isthmensis* of equal size, possibly because *picta* reaches a larger size.

The similarity of these young eleotrids and some young marine gobies, studied by the writer (1938), is striking. In the eleotrids, as in the marine gobies with fully united ventrals, the caudal fin is concave, not becoming round until pigmentation is general. The color markings of the juveniles, too, are similar, consisting in each group principally of black lines composed of short dashes on the median dorsal and ventral lines.

The relationship of this species and *pisonis* is discussed in the account of the last-mentioned species. The distinctive characters set forth apply to all the specimens preserved or examined, that were not taken in the Canal or waters connected with it, as well as to most of the individuals taken in the Canal. One rather notable exception, and a few less pronounced ones, which have some of the characteristics of both *pisonis* and *picta*, however, were found.

The most notable exception is a male specimen, 345 mm. long, taken in Pedro Miguel Locks. It has large scales like *pisonis*, which as in that species are scarcely or not at all embedded in advance of the dorsal. This fish has 62 oblique series of scales between the upper posterior angle of the gill opening and the base of the caudal on one side and 65 on the other, and 19 complete longitudinal rows between the bases of the second dorsal and the anal. In color this specimen agrees with *picta*, being quite pale ventrally

with only scattered brownish dots, and with no indications of dark lines along the rows of scales. This specimen, though having the characteristic concealed spine on the preopercular margin, differs from other specimens in having two small patches of vomerine teeth. The presence of these teeth is difficult to explain, as the genus is not supposed to possess them. Perhaps this specimen is merely a variant in that respect.

One female, 245 mm. long, from the lower flight of Miraflores Locks, though having small scales that are well embedded in advance of the dorsal, as characteristic of *picta,* nevertheless has rather definite dark lines along the rows of scales on the sides as in *pisonis.* A few small specimens from Miraflores Lake also have indications of dark stripes along the rows of scales, though less distinct and less definitely continuous.

It cannot be stated positively, because of the close relationship of the two species under consideration, that the specimens discussed, which have some of the characteristics of each species, are hybrids. However, the evidence seems to lead to that conclusion. If they are hybrids, then it follows that the species have intermingled by passing through Culebra Cut, and have cross-bred. As many individuals were present in Pedro Miguel Locks when the locks were dewatered in 1937 it seems probable that they pass through these single flight locks freely. Certainly no reason is evident why the species would not intermingle, as no barrier to prevent it seems to be present.

The sexes in this species may be distinguished by the shape of the anal flap, for in the male it is rather narrow distally, with a strongly convex to almost pointed margin, whereas in the female it is notably broader distally, with an almost straight posterior margin. Spawning apparently takes place during the dry season (about February to April), as five of seven specimens examined, two males and five females, taken February 20 and March 26, 1937, contained either large or developing roe.

Among eight specimens examined for food five had empty stomachs. One of the others had ingested an anchovy and the second one had fed on small mussels. The species is strictly carnivorous, as shown by these examinations and published accounts.

This fish is common in Miraflores Lake, and, as already stated, many individuals were found in Pedro Miguel Locks when the locks were dewatered in February, 1937. The species is not valued as food. Large examples offered to colored workmen were refused,

possibly because the heavy coating of mucus they always seem to possess makes them repulsive.

This species ranges from Lower California to Ecuador. It has been taken in virtually all the streams sampled in the Pacific slope of Panama. Though it was not secured in the Tuyra Basin by Meek and Hildebrand, it was recorded from there by Breder (1927, p. 142).

Eleotris pisonis (Gmelin).

Gobius pisonis Gmelin, Linn. Syst. Nat., p. 1206, 1788—Brazil.
Eleotris pisonis Meek and Hildebrand, Field Mus. Nat. Hist., Zool. Ser., **10**, p. 358, 1916.

Twenty-four specimens, ranging from 22 to 150 mm. in length, were collected in 1935 and 1937 in fresh-water streams at Fort Sherman (Toro Point), and Cativa; and in the dry dock at Mount Hope, and the lowest chamber (east side) of Gatun Locks. In the dry dock and the lowest chambers of Gatun Locks, the water is quite brackish to salty. In addition to the specimens listed, three juveniles, respectively 14, 15, and 19 mm. long, which apparently belong to this species, were taken in the lowest chamber of Gatun Locks, together with larger ones already listed. The characteristic preopercular spine is well developed in the 19 mm. fish, and it may be felt with a fine needle in the 15 mm. one, but it is not yet evident in the 14 mm. specimen. The 15 mm. specimen already has a few scales on the caudal peduncle where they seem to appear first, but the 14 mm. fish remains naked. This smallest specimen also remains largely unpigmented, whereas in the larger ones, pigmentation is general.

As this species and its Pacific slope congener, *picta*, ascend fresh-water streams and are fairly common, according to investigations made in 1911 and 1912, on both slopes of the Canal Zone in waters now included in or connected with the Canal, crossing over from one side to the other might be expected. However, no evidence that it has taken place was gained from the specimens collected in the dry dock at Mount Hope and Gatun Locks, though the situation is somewhat different in regard to specimens taken in Pedro Miguel and Miraflores Locks, and in Miraflores Lake, as stated in the account of *E. picta*.

This species differs from its Pacific slope relative, *picta*, in several minor respects, as pointed out by Meek and Hildebrand (1916, p. 356). The differences in the size of scales and the degree of embedding, together with the differences in color, are the principal recognition marks. The present species has somewhat larger scales

(59 to 68, most frequently about 64 in a lateral series, and about 18 complete longitudinal rows between the bases of second dorsal and anal, whereas *picta* has respectively 63 to 75, most frequently 67 to 69, and about 22), and they are not as greatly reduced in size in advance of the dorsal. Furthermore, they are scarcely or not at all embedded on the head in the present species, but rather fully in *picta*. In general, *pisonis* is darker ventrally, the color of preserved specimens being uniform brown, and the rows of scales along the sides are more or less distinctly marked with black lines. The ventral surface of the head, chest, and belly in *picta*, on the other hand, is rather pale, and is dotted, spotted, or marbled with brown, there being much variation among specimens, and there are no continuous dark lines along the rows of scales. Small specimens frequently have a dark band extending backward from the snout and eye. This band is much more frequently present in the Pacific slope specimens than in the Atlantic ones.

This species ranges from Florida to Brazil.

Eleotris isthmensis Meek and Hildebrand.

Eleotris isthmensis Meek and Hildebrand, Field Mus. Nat. Hist., Zool. Ser., **10**, p. 359, 1916—Mindi, Canal Zone.

Eleven specimens, ranging from 20 to 60 mm. in length, were collected in 1935 and 1937 at Fort Sherman (Toro Point) and at Puerto Pilón in fresh water, and in brackish to salt water in the lowest chamber of Gatun Locks. In addition, 22 juveniles, ranging from 14 to 18 mm. in length, which evidently belong to this species, were taken in the lowest chamber of Gatun Locks (east side). The smallest of these specimens already are well clothed with ctenoid scales posteriorly. The preopercular spine, characteristic of the genus, is present, and pigmentation is general. The caudal fin, however, remains concave to square. Development seems to be a little farther advanced in these fish than in young of the same size of *pisonis*, and much ahead of young of similar size of *picta*.

This species apparently agrees with *pisonis* in all respects, except that it has larger scales (45 to 53 oblique series between the upper posterior angle of gill opening and base of caudal, and 12 to 14 complete longitudinal rows between the bases of the second dorsal and the anal), which seem to be less adherent. The species apparently reaches even a smaller size than *pisonis*. The largest specimen known is only 85 mm. long, and those 50 to 60 mm. long are sexually fully mature.

The species is known only from the Atlantic slope of Panama, where it has been taken in or near brackish water. It apparently is rather less common than *pisonis.*

Guavina guavina (Cuvier and Valenciennes).

Eleotris guavina Cuvier and Valenciennes, Hist. Nat. Poiss., **12**, p. 223, 1837—Martinique.

Guavina guavina Meek and Hildebrand, Field Mus. Nat. Hist., Zool. Ser., **10**, p. 360, 1916.

No specimens of this species, which seems to be rather rare in Panama, were secured in 1935 nor 1937. Our earlier collections (1911 and 1912) contained only five specimens, collected in brackish ditches and creeks at Fort Sherman (Toro Point) and Colón.

The range of this fish extends on the Atlantic coast from somewhere in Mexico, through the West Indies, to Brazil.

Leptophilypnus Meek and Hildebrand.

Microeleotris Meek and Hildebrand, Field Mus. Nat. Hist., Zool. Ser., **10**, p. 362, 1916—type *M. panamensis.*

The generic name, *Microeleotris,* is placed in synonomy here for reasons stated in the account of *Leptophilypnus fluviatilis.*

Leptophilypnus fluviatilis Meek and Hildebrand.

Leptophilypnus fluviatilis Meek and Hildebrand, Field Mus. Nat. Hist., Zool. Ser., **10**, p. 361, 1916—Mindi, Canal Zone.

Microeleotris mindii Meek and Hildebrand, Field Mus. Nat. Hist., Zool. Ser., **10**, p. 364, 1916 - Mindi, Canal Zone.

This species was numerous in the "manholes" in the floors of the locks, especially in the chambers in which the water was nearly fresh. The fish could be seen clinging, very goby-like, to the walls of the holes in which water remains after the floors of the locks have been drained or pumped dry. The fish are not easily caught, however, as they cling close to the concrete walls of the "manholes," and are able to avoid nets fairly successfully. Specimens were secured in Gatun Locks: (*a*) uppermost chamber 27 specimens, 15 to 43 mm. long; (*b*) middle chamber two specimens, 38 and 40 mm. long; and (*c*) lowermost chamber one specimen, 35 mm. long; in Pedro Miguel Locks, 35 specimens, 20 to 33 mm. long; and in the upper chamber of Miraflores Locks, 16 specimens, 28 to 48 mm. in length. There are none from the lower chamber. In addition, three specimens were seined in Gatun Lake at Barro Colorado Island, and one in Miraflores Lake.

It was recorded only from a brackish creek at Mindi, Canal Zone (Atlantic side) by Meek and Hildebrand (1916, pp. 361–364), who recorded similar specimens from the same vicinity under the name *Microeleotris mindii;* and also *M. panamensis* from the Pacific slope from the Rio Chorrera and the Rio Juan Diaz. It should be noted that *M. panamensis* was not taken on the Pacific slope of the Canal Zone. The specimens now at hand cannot be separated definitely as to the genera *Leptophilypnus* and *Microeleotris,* which were described as differing chiefly in the width of the dentary bones, or rather as to whether they met at or near the posterior angles of the mouth. In *Leptophilypnus* they were described as meeting, leaving an oval-shaped naked area at the chin, whereas in *Microeleotris* these bones were said to be narrow and not meeting. I have re-examined paratypes of all three species placed in these genera,

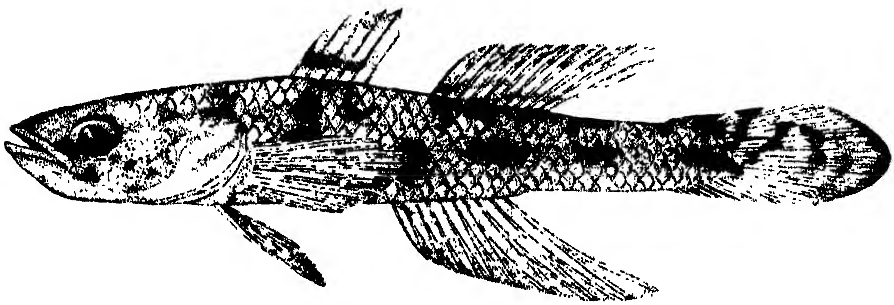

FIG. 10. *Leptophilypnus fluviatilis* Meek and Hildebrand. Specimen 50 mm. long. (From drawing by Andrew Pizzini.)

in connection with the specimens recently collected. The paratypes of *L. fluviatilis* are quite uniform as to the width and the approach to each other of the dentary bones, but the type material of *M. mindii* shows considerable variation in this respect, and in the material recently collected there is a wider degree of variation. In some specimens the bones meet and in others they are variously separated, some being fully half an eye's diameter apart. Apparently, the way the fish happens to die, that is, with the mouth open and the gill covers spread, makes a difference, but that does not account for the whole variation. It seems to be true also that typical examples of *M. mindii* have a wider head and a deeper caudal peduncle. However, the intergradation is complete. No tangible differences in the number of fin rays or scales were found among the type material, and I find none among the specimens at hand. I have concluded, therefore, that the genus *Microeleotris* is

not valid and that *M. mindii* is a synonym of *L. fluviatilis*. However, *M. panamensis* is a valid species, differing from *fluviatilis* in having smaller scales, in having (usually at least) 8 instead of 9 soft rays in the second dorsal and in the anal, and in having a broader head, as stated by Meek and Hildebrand (1916, p. 363), but generically it is not distinct.

As *L. fluviatilis* was not taken on the Pacific slope of the Canal Zone before the opening of the Canal, it seems probable that it has crossed over from the Atlantic. This fish, as already stated, was numerous in those chambers of the locks at both ends of the Canal that are fairly fresh, where it seemed to be peculiarly at home. No reason is known why the members of the species should not migrate freely between the locks at the opposite ends of the Canal. This fish is known only from the Canal Zone.

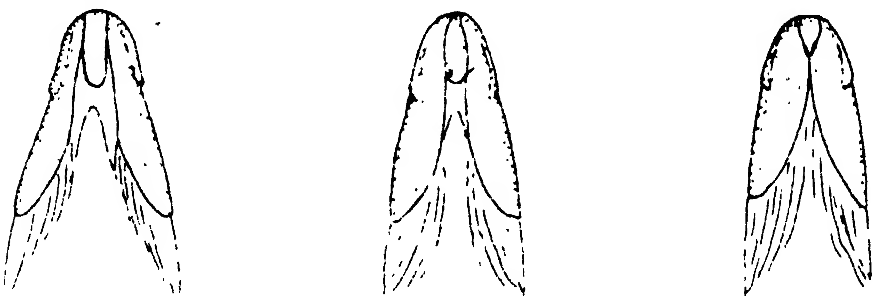

FIG. 11. *Leptophilypnus fluviatilis* Meek and Hildebrand. Ventral surface of heads of three specimens, showing variation in width and in space between dentary bones.

Leptophilypnus panamensis (Meek and Hildebrand).

Microeleotris panamensis Meek and Hildebrand, Field Mus. Nat. Hist., Zool. Ser., **10**, p. 363, 1916—Rio Juan Diaz.

In our earlier work this species was placed in the genus *Microeleotris*, which proves to be invalid. However, *panamensis* has been shown to be a valid species. It is not in the present collection, and remains known only from the type material from the Rio Chorrera and the Rio Juan Diaz, which was re-examined in part.

Euleptoeleotris gen. nov.

Genotype *Euleptoeleotris clarki* sp. nov.

This genus agrees with *Eleotris*, (*a*) in having broad bands of teeth on the jaws and none on the vomer, (*b*) in having the gill openings restricted (extending scarcely to margin of preopercle), and (*c*) in having a somewhat concealed downward projecting

spine on the lower posterior angle of the preopercular margin. It differs from that genus, however, (*a*) in having a much more slender body (depth about 6.5 to 8 in standard length), (*b*) in having much smaller scales (125 or more in a lateral series), which are all cycloid, and (*c*) in having more numerous simple or rudimentary caudal rays (11 to 13 above and below), which extend much farther forward on caudal peduncle, about to joint between the third and fourth vertebrae. Vertebrae about 9 or 10+15 or 16.

Euleptoeleotris clarki sp. nov.

Type from Miraflores Locks, Canal Zone. No. 106508 United States National Museum. Female. Total length 127 mm., standard length 104 mm.

Description of the type.—Head 4.5; depth 8; D. VI–I, 13; A. I, 11; P. 18; scales too small to enumerate accurately, about 175 in a lateral series.

Body very slender, compressed posteriorly; depth of caudal peduncle 2.4 in head; head depressed, the width exceeding the depth by fully an eye's diameter; snout rather long, 5.1 in head; eye small, directed upward only slightly, 10.2; interorbital 8.2; mouth large, oblique, lower jaw strongly projecting; maxillary reaching under middle of eye, 3.1 in head; gill openings restricted, extending forward scarcely to preopercular margin; scales reduced in size anteriorly, but scarcely embedded; head with many rows of pores, especially around the eyes; dorsal fins well separated, none of the spines of the first reaching the origin of the second if deflexed, the origin of the second about equidistant from the posterior margin of the eye and the base of the caudal; caudal somewhat pointed, the longest rays nearly as long as the head, with 12 rudimentary rays above and 11 below, extending forward on caudal peduncle a distance fully equal to the depth of the peduncle; anal fin similar to second dorsal, its origin about an eye's diameter posterior to origin of second dorsal; ventrals rather small, 2.1 in head; pectorals notably larger, pointed, the middle rays being somewhat produced, reaching about half their length beyond tips of ventrals, 1.5 in head.

Color of preserved specimen uniform light brown above, paler ventrally, the chest and abdomen being pale with many dark dots; a dark blotch behind upper part of gill opening; sides with indications of pale cross lines except on peduncle. Dorsal and pectoral fins rather pale with blackish spots, the latter with a dark blotch at base; caudal darker, with indications of black spots; anal and ventrals pale, with scattered dark points.

Variations noticed in the paratypes are as follows: Head 4 to 4.6; depth 7.5 to 8.5; D. VI–I, 12 or 13; A. I, 10 or 11; P. 17 to 19; rudimentary rays of caudal 11 or 12 both above and below peduncle; scales too small to enumerate accurately, about 150 to 175; vertebrae 9+15 or 16. Snout 5 to 5.6 in head; eye 8.4 to 10.2; interorbital 5.5 to 8.5; maxillary 2.8 to 3.2; ventral fin 2 to 2.4; pectoral 1.4 to 1.8; caudal peduncle 2.4 to 3. Some specimens are paler than others. The paler specimens have no definite dark blotch on the base of the pectoral.

The sexes in this species, as in *Eleotris*, can be recognized by the shape of the anal flap, that of the female being broadly rounded to nearly square distally, whereas in the male it is somewhat pointed. In general, the dorsal and anal fin rays seem to be somewhat higher in males than in females. It is not evident that the caudal fin is longer in males than in females, nor that it increases in proportionate

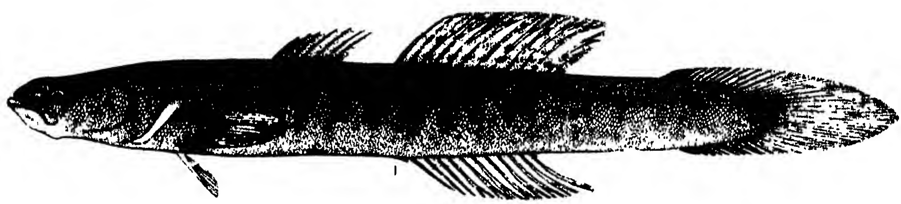

FIG. 12. *Euleptoeleotris clarki* gen. et sp. nov. Type, female, 127 mm. long. (From drawing by Andrew Pizzini.)

length with age, the length varying from slightly shorter to slightly longer than the head.

This species is represented in the collection by 11 specimens, ranging in length from 63 to 150 mm., all taken in Miraflores Locks, partly in the upper and partly in the lower chambers.

It affords me pleasure to name this species for Dr. Herbert C. Clark, director of the Gorgas Memorial Laboratory, who made it possible to carry on the investigations resulting in the discovery of this and several other new species of Panamanian fishes.

Euleptoeleotris shropshirei sp. nov.

Type from a dry dock, Mount Hope, Canal Zone. No. 106507 United States National Museum. Female. Total length 53 mm., standard length 42 mm.

Description of the type.—Head 4.1; depth 8.2; D. VI–I, 10; A. I, 9; P. 18; scales too small to enumerate accurately, probably about 125 in a lateral series.

Body very slender, compressed posteriorly; depth of caudal peduncle 3.4 in head; head depressed, fully an eye's diameter wider than deep; snout moderately long 5.1 in head; eye moderate, scarcely directed upward, 5.8; interorbital 9.3; mouth large, oblique, lower jaw projecting; maxillary reaching middle of eye, 3.3 in head; gill openings restricted, not quite extending forward to margin of preopercle; scales somewhat reduced in size anteriorly, scarcely embedded, all cycloid; head with many rows of pores about the eyes; dorsal fins far apart, none of the spines of the first reaching the second if deflexed; origin of the second dorsal almost equidistant from posterior margin of the eye and base of caudal; caudal fin somewhat pointed, the longest rays equal to length of head, with 11 rudimentary rays above and 11 below, extending forward on the caudal peduncle a distance about equal to depth of peduncle; anal similar to second dorsal, its origin scarcely an eye's diameter posterior to origin of second dorsal; ventrals small, 2 in head; pectorals much larger, pointed, reaching nearly half their length beyond tips of ventrals, 1.5 in head.

Color of preserved specimen light brown, pale underneath; a rather conspicuous black blotch behind upper part of gill opening; sides anteriorly with suggestions of pale cross-lines. Dorsal and caudal fins somewhat darker brown than the back, without definite dark spots; anal fin paler brown than dorsals and caudal, also unspotted; ventrals and pectorals pale, with brownish points.

A single paratype, a male, 55 mm. long, taken in the mouth of a brackish creek at Puerto Pilón (Atlantic side) is at hand. The following proportions and counts are based on this specimen: Head 3.5; depth 6.5; D. VI–I, 10; A. I, 9; P. 17; scales too small and irregular to enumerate, probably about 125 in lateral series. Snout 5.3 in head; eye 6; interorbital 9.3; maxillary 3; caudal peduncle 3.2. The paratype, being a male, has higher dorsal and anal fins than the holotype, and the caudal fin is longer and more sharply pointed, the longest rays a little longer than the head. This specimen, including the fins, is much darker brown than the holotype, and the vertical fins (especially the caudal) have definite black spots. No dark blotch is evident, however, behind the upper part of the gill opening as in the holotype.

The two small specimens of this species are insufficient to determine the exact difference between it and *clarki*. Apparently the second dorsal and anal fins are a little shorter in *shropshirei*, each having 1 to 3 fewer rays, as shown in the descriptions. Furthermore,

the scales, though they cannot be enumerated definitely, apparently are larger in *shropshirei*. It is judged from the fully developed fins (those of the male being somewhat produced) and anal flap that the small specimens of *shropshirei* are sexually fully mature. A specimen of *clarki* of somewhat similar size (63 mm. long) at hand has this secondary sexual character little developed and so imperfectly that it is impossible to determine the sex by its shape. This difference in development suggests that the Atlantic coast species, as in *Eleotris*, reaches maturity at a smaller size, and also that it probably attains a smaller size. *E. shropshirei* apparently has a larger eye and longer pectoral and ventral fins, as shown in figures 12 and 13.

As it is not evident from the material at hand that the species of this genus enter strictly fresh water, it apparently may be assumed

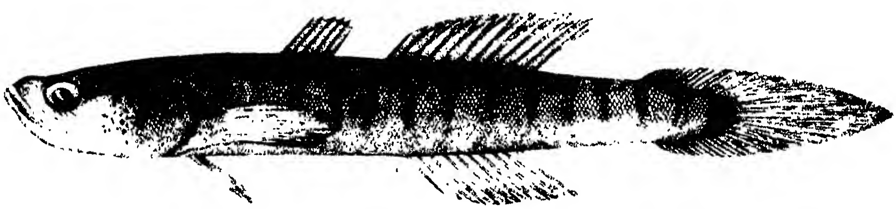

FIG. 13. *Euleptoeleotris shropshirei* sp. nov. Type, female, 53 mm. long. (From drawing by Andrew Pizzini.)

that no crossing over from one side to the other through the Canal has taken place.

This species is named in honor of J. B. Shropshire, supervisor of malaria control for the United States Army in Panama, who took the holotype in the dry dock at Mount Hope, when it was pumped out, and who assisted the writer in many other ways while he was working in Panama in 1937.

Hemieleotris latifasciatus (Meek and Hildebrand).

Eleotris latifasciatus Meek and Hildebrand, Field Mus. Nat. Hist., Zoöl. Ser., **10**, p. 68, 1912—Rio Cárdenas, Pacific slope, Panama.

Hemieleotris latifasciatus Meek and Hildebrand, Field Mus. Nat. Hist., Zool. Ser., **10**, p. 365, pl. 32, 1916.

A single specimen, 65 mm. long, was taken in the Rio Pacorá (Pacific slope).

This species is reported from the Pacific slope from Costa Rica and Panama to southern Colombia.

Awaous Cuvier and Valenciennes.

Awaous Cuvier and Valenciennes, Hist. Nat. Poiss., **12**, p. 97 (quarto ed., p. 73), 1837; Steindachner, Sitzber. Akad. Wiss., Wien, **42**, p. 289 (1860?); Ginsburg, Proc. U. S. Nat. Mus., **82**, art. 20, pp. 20-21, 1933.

As shown by Ginsburg, the name *Awaous* dates from Cuvier and Valenciennes, 1837, rather than from Steindachner, 1860 or 1861, and has clear priority over *Chonophorus* Poey, 1860.

Awaous taiasica (Lichtenstein).

Gobius taiasica Lichtenstein, Abhandl. Preuss. Akad. Wiss., Berlin, **1822**, p. 273—Brazil.

Awaous taiasica Meek and Hildebrand, Field Mus. Nat. Hist., Zool. Ser., **10**, p. 366, 1916.

This fresh-water goby is represented in the recent collections by four specimens, 57 to 85 mm. long, all takén by J. B. Shropshire in a fresh-water stream at Fort Sherman (Toro Point), where Meek and Hildebrand did not obtain it in 1911 and 1912, although they collected there. The specimens conform well to the description of specimens from the Chagres Basin by Meek and Hildebrand (1916, p. 367). Behre (1928, p. 311) recorded it from creeks flowing into Almirante Bay, western Panama. The probable range of this species was given by us (1916, p. 368) as extending on the Atlantic slope from Mexico to Brazil. Eigenmann (1922, p. 216) since has shown that another species inhabits the Atlantic slope of Colombia (Atrato and Magdalena basins), which he named *A. decemlineatus*. He did not state whether *taiasica* also occurs there. If not, the Panama fish probably also is different from the Brazilian form on which *taiasica* is based. If that be true, which cannot now be determined for want of time and material, the Panama species, unless one of the several supposed synonyms of *taiascia* based on Central American, Mexican, and West Indian specimens is available, would be without a name.

Awaous transandeanus (Günther).

Gobius transandeanus Günther, Cat. Fish. Brit. Mus., **3**, p. 62, 1861—western Ecuador.

Awaous transandeanus Meek and Hildebrand, Field Mus. Nat. Hist., Zool. Ser., **10**, p. 368, 1916.

This species is represented by five specimens, ranging in length from 17 to 51 mm., all taken in small coastal streams between Campaña and La Venta. Juveniles were common on sandy bottom in very shallow quiet water in a small stream near La Venta, but they were so small and slender that they mostly escaped through the meshes of a bobbinet seine.

The differences between this and the Atlantic slope form seem to be correctly set forth by Meek and Hildebrand (1916, p. 366). Dark crossbars present in this species, but not in *taiasica*, are especially prominent in juveniles.

Eigenmann (1922, p. 216) gave the range of this species as extending southward on the Pacific slope to Colombia and Ecuador. Northward it ranges to Mexico.

Sicydium salvini Grant.

Sicydium salvini Grant, Proc. Zool. Soc. Lond., **1884**, p. 159, pl. 12, fig. 2—Panama; Meek and Hildebrand, Field Mus. Nat. Hist., Zool. Ser., **10**, p. 369, 1916.

This species is not in the present collection. It is known from both slopes of central Panama, and ranges to the Magdalena Basin in Colombia and to western Ecuador.

Sicydium pittieri Regan.

Sicydium pittieri Regan, Ann. Mag. Nat. Hist., (7), **19**, p. 260, 1907—Rio Grande de Térraba, Costa Rica.

This species is included in the Panama fauna on the basis of a record by Behre (1928, p. 312), who secured six specimens in a small stream tributary to the Rio Chiriquí del Tire (Pacific slope), western Panama.

This fish apparently differs chiefly from *Sicydium salvini*, the only other species recorded from Panama, in the naked area on the median part of the belly. However, Eigenmann (1922, p. 214) found a naked area, also, in small specimens of *salvini*. The fin-ray and scale counts of the two species seem to agree.

The range, as far as known, is Costa Rica and western Panama; possibly on the Pacific slope only.

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NOTES ON THE ANATOMY OF THE BABIRUSA

BY

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NOTES ON THE ANATOMY OF THE BABIRUSA

BY D. DWIGHT DAVIS

Recent studies of the phylogeny of the pigs have been based on comprehensive examination of fossil material. Interpretations in these studies are necessarily based chiefly on dental characters. The large differences in the soft anatomy of various living genera may, however, be accompanied by only slight differences in dentition. It is therefore evident that the interpretations derived from fossil material require a check in the light of the whole anatomy of the living forms. Unfortunately there prove to be large gaps in knowledge of the Suidae, and these must be filled out by studies of various genera as they become available. The babirusa is outstandingly different from other suids in external appearance, and certain equally unusual features of its soft anatomy have long been known.

Nearly a century has passed since Vrolik (1844) dissected two male babirusas that died in the Amsterdam zoological garden. Modern standards leave much to be desired in his brief and incomplete descriptions, which with a few exceptions represent all that is known of the anatomy of this animal. Beddard (1909) studied two babirusa brains, but concluded that the divergences from other suids were "only slight."

Therefore, when a fine adult *Babirussa babyrussa* Linnaeus in the collection of the Chicago Zoological Society died recently and was presented to Field Museum through the generosity of the authorities of the Society, it was embalmed and injected and the following notes made before it was reduced to a skeleton. It is to be regretted that circumstances did not permit complete dissection of the cadaver, since the anatomy of the Suidae, except the domestic hog, is almost unknown. This has made it difficult to evaluate the results of the present study. For the most part such evaluation must await future work on other members of the family.

The animal was an adult male, with a head-and-body length of 1040 mm.; the tail measured 275 mm. The skull has a total length of 310 mm. and a maximum zygomatic breadth of 120 mm. Unfortunately, the animal was not weighed.

Armour and Company of Chicago supplied material of domestic animals needed for comparison, and grateful acknowledgment is hereby made to that organization, especially to Dr. J. B. Porsche

of its chemical research department. Certain comparisons have also been made with the viscera of a white-lipped peccary (*Tayassu pecari*) obtained at Belize, British Honduras, by the recent Mandel Caribbean Expedition of Field Museum. I am under continued obligation to my colleagues: to Mr. Karl P. Schmidt for help in translating difficult German passages, and to Mr. Bryan Patterson for helpful advice and criticism. The drawings, which have been planned and executed with great care, are the work of Miss Elizabeth Story, who is also to be credited with much of the painstaking dissection of the blood vessels.

MUSCULAR SYSTEM

Attention has been directed chiefly to the muscles of the limbs and limb girdles, and examination of the rest of the musculature was more or less incidental and unsystematic. The classic studies of Windle and Parsons on the myology of ungulates (1901, 1903) greatly facilitated this part of the study, and comment is in general restricted to conditions that differ from their summaries. Vrolik apparently studied the muscles of his babirusas in considerable detail, but his descriptions are so general that they are often of little value.

MUSCLES OF THE HEAD AND BODY

M. platysma forms a rather heavy, wide sheet, 110 mm. in width, arising over the shoulder just caudad of the scapulo-humeral articulation, and running down over the ventral side of the ramus of the mandible. It meets its fellow of the opposite side at the midline of the sublingual region. The muscle terminates on the external side of the mandible at the level of the corner of the mouth.

M. sternofacialis is well developed and lies superficial to the platysma, as is usual in the Suidae. It arises from the tip of the manubrium sterni, separated from its mate of the opposite side by an interval of 6 mm., and expands in fan shape over the front of the shoulder. It terminates in the fascia over the platysma at about the level of the shoulder articulation.

M. masseter is composed of a superficial and a deep layer. The zygomatic half of the superficial layer is covered with a heavy tendinous aponeurosis. Origin is from the entire length of the ventral border of the zygoma. The deep layer is somewhat less extensive anteriorly; its entire external surface is covered with a heavy tendinous aponeurosis.

M. temporalis is divided into superficial and deep layers. The superficial layer is much the smaller, and arises from the entire

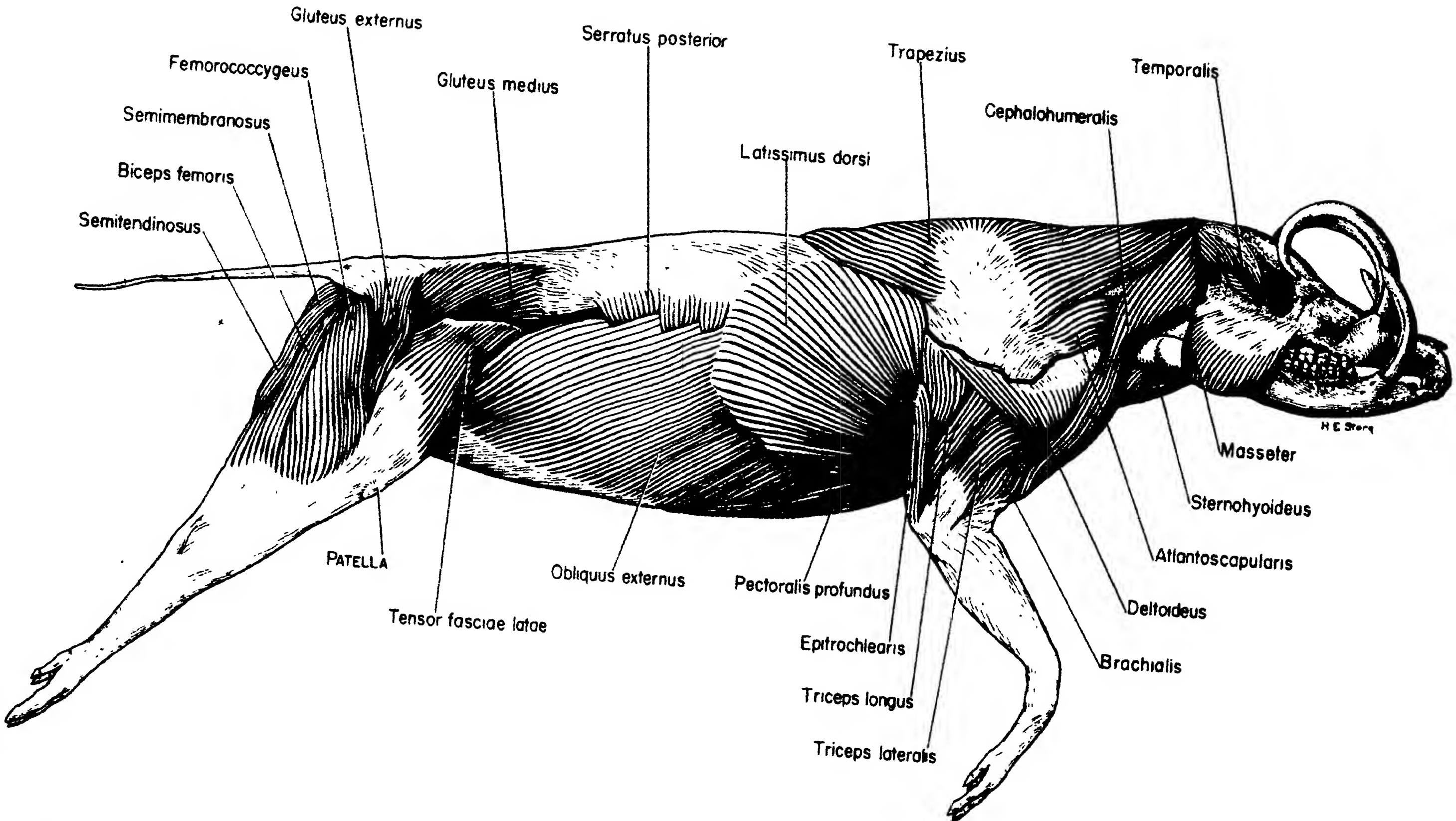

FIG. 14. Superficial musculature after removal of the panniculus. Tendons of the deltoideus and tensor fasciae latae have been largely removed.

postorbital length of the zygomatic arch. The deep layer has the usual origin from the temporal fossa. The fiber direction of the superficial layer is nearly horizontal, while that of the deep layer is diagonal.

M. digastricus is composed of a single belly, which arises by means of a stout tendon from the paroccipital process and inserts extensively on the ramus of the mandible.

M. sternomastoideus arises from the side of the manubrium and passes craniad, diverging from the midline, to the paramastoid process, where it inserts.

M. cleidomastoideus arises from the tendinous intersection in the cephalohumeral and passes craniad to its insertion on the paramastoid process, deep to the insertion of the sternomastoid.

M. sternohyoideus arises from the anterior tip of the manubrium. At its origin it is very narrow from side to side and very deep dorsoventrally. It gradually widens in the gular region, running forward in contact with its mate at the midline.

M. atlantoscapularis (omo-trachelian of Windle and Parsons) is a flat band arising from the fascia over the acromial region of the scapula. It is visible superficially in the interval between the trapezius and cephalohumeralis. Insertion is made into the transverse process of the atlas.

Mm. scaleni dorsales are composed of two entirely separate muscles, both of which are dorsad of the brachial plexus. One, wider and more superficial and apparently representing the longus, arises from the first, third, and fourth ribs, apparently with no attachment to the second, and inserts on the transverse processes of the fourth and fifth cervical vertebrae. The other arises from the anterior border of the first rib, beneath the origin of the foregoing part, and inserts on the transverse processes of the third and fourth cervical vertebrae; the insertion into the fourth is craniad of the insertion of the long division of the scalenus.

M. scalenus ventralis arises from the first rib and inserts on the transverse processes of the fourth, fifth, sixth, and seventh cervical vertebrae.

M. panniculus carnosus forms an extensive sheet covering the lateral and ventral surfaces of the body. Posteriorly the fibers run down on the front of the thigh about halfway to the knee. The ventral edge of the muscle reaches the midline in front of the prepuce. The most ventral fibers insert into the ventral fascia, while the more dorsal fibers converge toward the axilla, to insert with the latissimus.

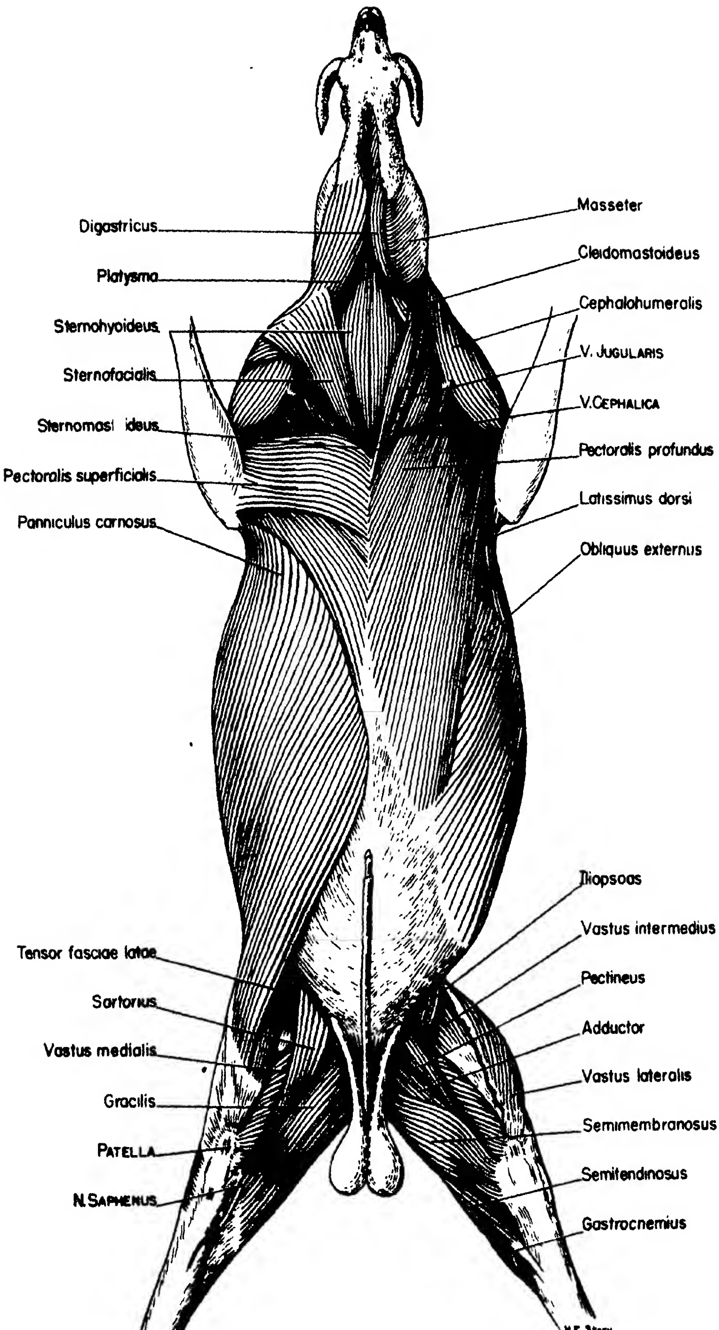

FIG. 15. Musculature from the ventral side. Superficial layers are on the left, deeper muscles on the right.

M. pectoralis superficialis is composed of separate anterior and posterior divisions. The *anterior* division is heavier and narrower than the posterior one, and is slightly overlapped by it. It arises from the manubrium sterni and inserts into the pectoral ridge of the humerus at about the middle of the shaft of the humerus. A narrower deeper slip has the same origin and inserts into the pectoral ridge partly deep to and partly distad of the main part. The *posterior* division is a thin rectangular sheet arising from the sternum, and inserting into the medial end of the bicipital arch and the fascia of the medial side of the forearm.

M. pectoralis profundus arises from the ventral midline, from the posterior sternebrae and continues to a point 80 mm. caudad of the end of the sternum. The most anterior fibers (pectoralis minor of most authors) arise from the side of the manubrium and pass over the front of the shoulder, to insert into the fascia over the supraspinatus. Immediately caudad of and parallel to this is another slip which forms a tendinous intersection with the cephalohumeralis at the former site of the clavicle. The main mass of the profundus (quartus of Windle and Parsons) inserts into the proximal end of the pectoral ridge and the greater tuberosity; the most anterior fibers accompany the coracobrachialis beneath the supraspinatus, inserting with the former.

MUSCLES OF THE SHOULDER AND FORELIMB

M. trapezius is very well developed, as is usual in the Suidae. It is in contact with the cephalohumeralis for 130 mm. dorsally. Origin is taken from the lambdoidal crest and back along the dorsal midline of the neck. The most posterior fibers do not reach the midline, but arise by means of an aponeurotic sheet. The fibers running toward the coracoid border of the scapula stop abruptly at the scapular border and are replaced by a heavy aponeurosis, which continues across the supraspinatus to the usual insertion on the scapular spine. The fibers running toward the neck of the scapula insert into the fascia over the scapular muscles.

M. cephalohumeralis arises from the entire occipital crest. The division between the clavotrapezius and clavodeltoid parts of this muscle is indicated only by a slight tendinous intersection on the ventral border, where a few of the most anterior fibers of the deep pectoral leave the main pectoral mass and join the cephalohumeral. The cleidomastoid division of the cephalohumeral also leaves the main mass of the muscle at this level.

M. latissimus dorsi takes origin from ribs 9–11; its dorsal fibers are continued, as usual, onto the dorsal fascia by aponeurosis, which continues caudad from the sixth thoracic vertebra. The anterodorsal border of the muscle is overlapped slightly by the trapezius. The latissimus joins the teres major where the two muscles lie across the triceps longus, and they insert by a common tendon into the shaft of the humerus.

M. rhomboideus is composed of two parts, which apparently represent the so-called *capitis* and *colli.* The capitis is much more extensive, arising from the lambdoidal crest and from the ligamentum nuchae as far back as the fourth thoracic vertebra. The colli lies beneath the preceding part, the posterior borders of the two muscles being approximately coextensive; the anterior fibers of the colli arise aponeurotically, the origin extending forward to about the third cervical vertebra.

M. supraspinatus forms a heavy mass arising from the supraspinous fossa and around the coracoid border onto the subscapular surface, where it forms a tendinous intersection with the subscapularis. Insertion is by fleshy fibers into the prominent curved border running mesad from the greater tuberosity.

M. infraspinatus arises from the infraspinous fossa of the scapula and suprascapula, and inserts into the prominent infraspinous scar on the greater tuberosity of the humerus.

M. deltoideus arises by means of an extensive aponeurosis from the scapular spine, from the fascia of the supraspinatus, and on its internal face even from the tendon of the triceps lateralis. Insertion is chiefly into the deltoid ridge, some of the ventral fibers going to the fascia of the forearm.

M. teres major arises from the posterior part of the axillary border of the scapula and from the fascia separating the teres major and the subscapularis. Insertion is made, by a flat tendon common to it and the latissimus dorsi, into the usual scar on the external side of the shaft of the humerus. The latissimus dorsi lies deep (external) to the teres major at this point.

M. teres minor arises, as usual, from the teres minor fossa along the axillary border of the scapula; many of the fibers arise from the heavy fascia separating this muscle from the infraspinatus. Insertion is into the prominent tubercle on the lower border of the greater tuberosity, immediately below the insertion of the infraspinatus.

M. subscapularis is divided into four bundles. Its entire inner surface is covered by a heavy tendinous aponeurosis. Origin is from

about the ventral two-thirds of the subscapular fossa, and insertion is by means of a stout tendon into the lesser tuberosity of the humerus.

M. biceps arises by a stout, somewhat flattened tendon, from the bicipital tubercle immediately ectad of the coracoid process; the

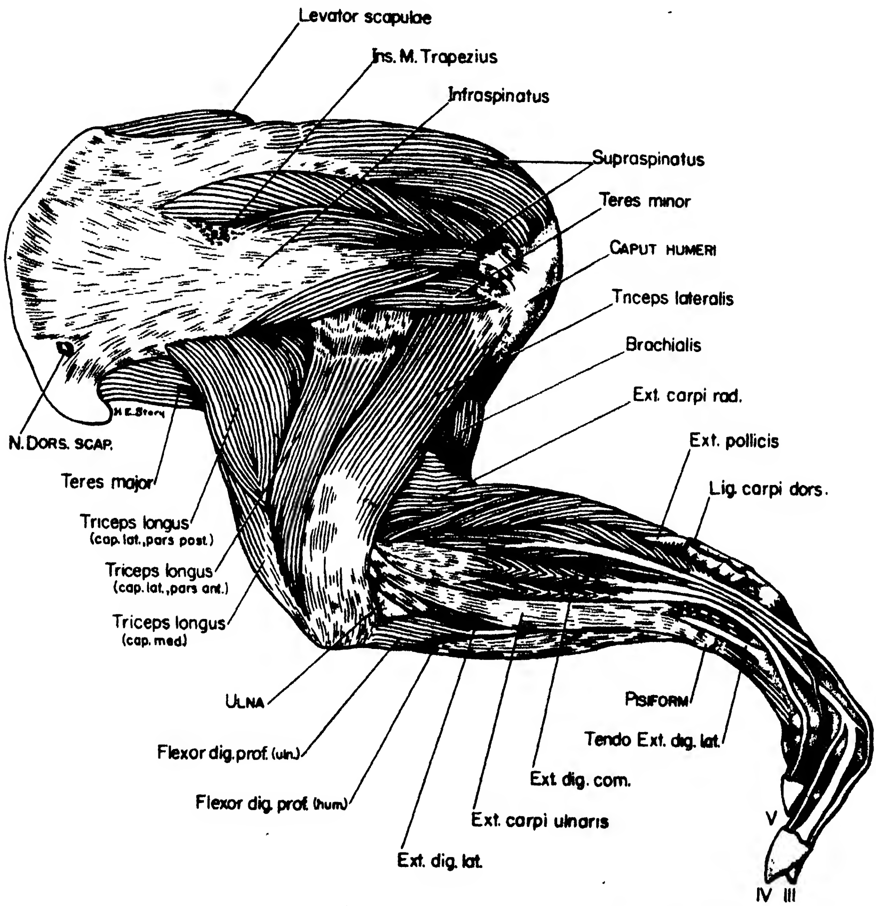

FIG. 16. Musculature of right shoulder and foreleg, lateral aspect.

tendon passes through the shoulder capsule. Insertion is chiefly into the radius, although the tendon continues across the medial side of the radius onto the ulna. There is a fibrous expansion, corresponding in position to the lacertus fibrosus of human anatomy, that joins the fibrous vestige of the pronator teres.

M. coracobrachialis is divided into well-marked short and long heads, between which passes the branch of the musculocutaneus nerve that supplies the biceps and the internal circumflex humeral

artery. In the presence of both heads *Babirussa* apparently differs strikingly from *Sus* (Windle and Parsons; Sisson); Vrolik's description is not clear as to whether more than one head was present in his specimens. The two heads arise by a wide, flat tendon from the coracoid process and the surrounding shoulder capsule. The short

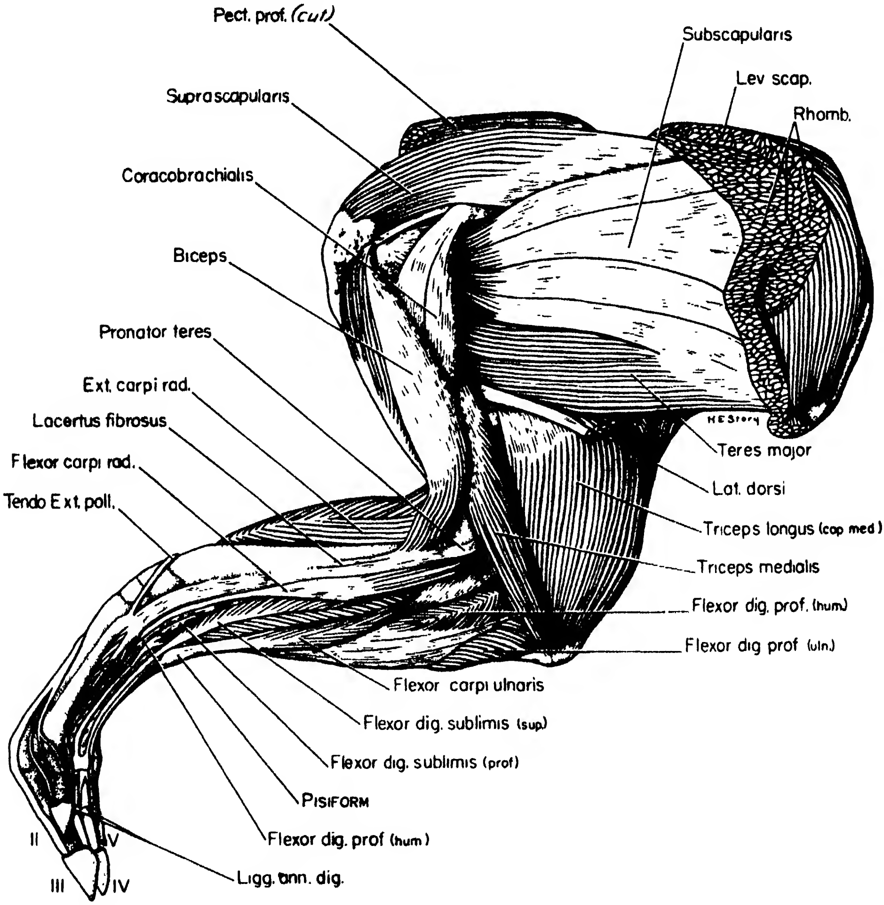

FIG. 17. Musculature of right shoulder and foreleg, medial aspect.

head inserts fleshily into the neck of the humerus immediately above the tendon of the latissimus and teres major. The long head forms a very wide flat tendon where it passes beneath the biceps. This tendon inserts into the anterior edge of the shaft of the humerus about midway between the two ends of the bone.

M. brachialis has the usual origin from the lateral side of the surgical neck of the humerus. Insertion is exclusively into the radius,

attachment being into its medial border immediately laterad of the insertion of the biceps. Windle and Parsons were inclined to believe that this muscle invariably inserts on the ulna in ungulates, while Sisson gives both the radius and ulna for the domestic hog.

M. epitrochlearis is a thin but extensive muscle covering the whole posterior and about half of the medial parts of the upper arm. It arises, by a thin tendon medially which gradually gives way to fleshy fibers posteriorly, from the latissimus dorsi. Insertion is into the posterior and medial borders of the olecranon.

M. triceps longus is, as usual, much the largest element of the triceps complex. It is composed of lateral and medial heads. The

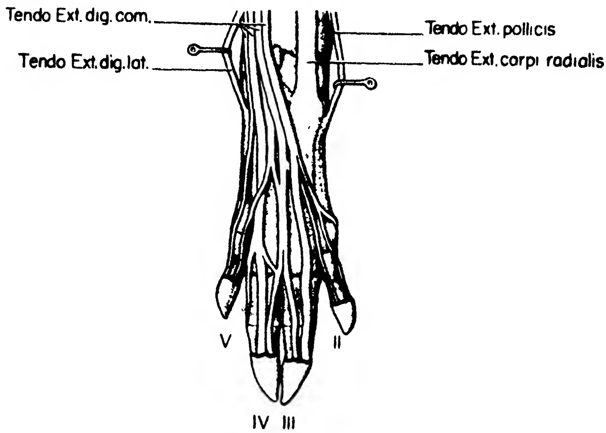

FIG. 18. Tendons of right manus, anterior view.

lateral head in turn is divided into distinct anterior and posterior elements. The anterior part of the lateral head arises tendinously from the axillary border of the scapula near the head; the posterior part arises similarly just posteriorly, with accessory origin from the fascia over the infraspinatus. The medial head arises from the axillary border opposite the origin of the anterior part of the lateral head. The two heads fuse and insert into the tip of the olecranon.

M. triceps lateralis arises, by means of a wide tendon, from the neck of the humerus. Proximally, it covers a considerable part of the brachialis. Insertion is made into the external surface of the olecranon, by means of a tendinous aponeurosis.

M. triceps medialis arises extensively from the postero-medial surface of the shaft of the humerus, from a point just below the head distad. Insertion is into the medial border of the olecranon.

M. pronator teres is represented by a heavy tendinous band running from the internal condyle of the humerus to the distal end of the radius.

M. flexor carpi radialis is a slender fusiform muscle arising from the internal condyle of the humerus. It terminates, at about the juncture of the middle and distal thirds of the radius, in a long tendon that inserts into the base of metacarpal II.

M. palmaris longus is absent, as is usual in the higher ungulates according to Windle and Parsons.

M. flexor carpi ulnaris is a narrow ribbon-like muscle arising from the internal condyle immediately below the origin of the flexor

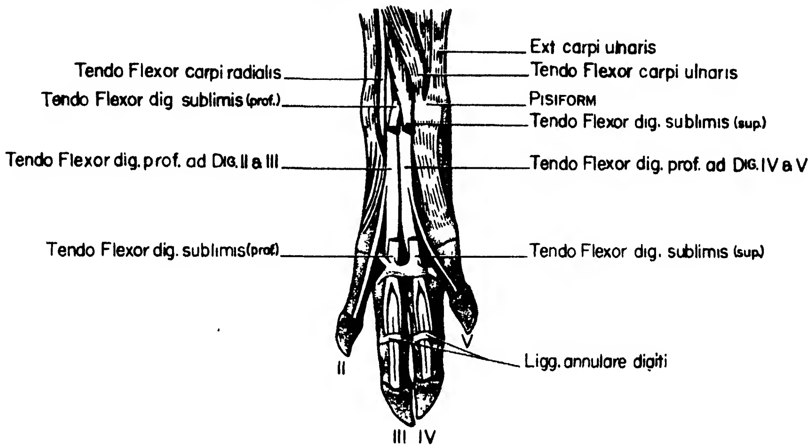

FIG. 19. Tendons of right manus, posterior view.

carpi radialis; the olecranal head is absent. The muscle crosses over the flexor digitorum sublimis to reach the tip of the pisiform, where it inserts, chiefly by fleshy fibers.

M. flexor digitorum sublimis is composed of two heads, which arise from the internal condyle between the origins of the two condylar heads of the profundus. The tendon of the deeper head passes through a tunnel formed by the common tendon of the profundus. The terminal tendon of the deep head of the sublimis inserts into the second phalanx of digit III; that of the superficial head inserts into digit IV (fig. 19).

M. flexor digitorum profundus is composed of three heads, two condylar and one olecranal. This agrees with the description given by Sisson; Windle and Parsons state that there are five heads in the Suidae. The condylar heads are very unequal, the one on the ulnar

side of the forearm greatly exceeding its mate in size. The olecranal head is short and triangular, terminating abruptly in a long flattened tendon, which maintains its independence as far as the carpus; there it joins the powerful common tendon of the condylar heads. The common tendon splits into four divisions, which are distributed to the terminal phalanges of the four digits; as usual, the tendon divisions to the two middle toes are larger than those to the lateral toes (fig. 19).

M. brachioradialis is absent, as usual in the Suidae.

M. extensor carpi radialis is represented by a single muscle, apparently the brevis. It is a heavy muscle taking extensive origin from the lateral supra-condylar ridge. Distally as it passes beneath the dorsal carpal ligament it forms a stout flat tendon, which inserts into the proximal end of metacarpal III.

M. extensor digitorum communis arises from the external condyle of the humerus. It is composed of four fleshy bellies, which have a complex tendon arrangement. Numbering these bellies from the medial (radial) side outward, the tendons are distributed as follows (fig. 18): The tendon from the *first* belly splits, the resulting two tendons going to the second and third digits. There are two tendons from the *second* belly. The more medial of these gives off a slender tendon to the second digit, then splits near the distal end of the metacarpus; further subdivisions of the resulting two tendons supply each phalanx of the third and fourth digits. The more lateral tendon subdivides again, one branch joining the medial tendon, while the other goes to the fifth digit. The tendon from the *third* belly goes exclusively to the fourth digit, except for a short medial branch that joins the tendon of the second belly to digit IV. The tendon from the *fourth* belly goes to the fifth digit. No record of this muscle being divided into four bellies in *Sus* was found, although Windle and Parsons cite Cuvier and Laurillard's record of a peccary in which there were four.

M. extensor digitorum lateralis lies mostly beneath the extensor carpi ulnaris. It arises from the external condyle partly beneath and partly distad of the extensor carpi ulnaris. Insertion is by means of a long, somewhat flattened tendon into the proximal end of metacarpal V. Tendons normally go to IV and V in *Sus;* there was a single tendon to V in the *Sus* (=*Potamochoerus*) *porcus* dissected by Windle and Parsons.

M. extensor carpi ulnaris agrees with that of other Suidae in being entirely tendinous. It has the usual origin from the external

condyle of the humerus, and inserts into the pisiform. Near its insertion the tendon is pierced by the tendon of the extensor digitorum lateralis.

M. extensor pollicis is a bipinnate muscle arising from the distal half of the shaft of the ulna and radius. It terminates in a narrow tendon that crosses over that of the extensor carpi radialis, to insert into the proximal end of metacarpal II.

MUSCLES OF THE HIP AND THIGH

M. psoas major is asymmetrically developed on the two sides of the body (fig. 20). On the left side, which is apparently normal, it is a wide, flat sheet extending forward to the thirteenth rib; posterior to the fourth lumbar it presents a glistening tendinous surface ventrally. Insertion is into the lesser trochanter. On the right side the psoas major is composed of independent slips. The more anterior of these extends from the twelfth rib to the third lumbar, where it forms a stout round tendon that continues caudad, to insert into the fascia below the ilium. The second slip arises tendinously from the fourth lumbar and fleshily from the succeeding lumbars, and has the normal insertion of the psoas major.

M. psoas minor is a narrow muscle extending forward to the centrum of the thirteenth thoracic vertebra. Insertion is, as usual, into the pectineal eminence.

M. iliacus is not laterally compressed, as Windle and Parsons state that it is in ungulates, but is rather wide, and spatulate at its origin. It has the usual origin from the ventral surface of the ilium and the margin of the sacrum. The muscle is more or less inseparable from the psoas major, and inserts by a common tendon with it into the lesser trochanter.

M. quadratus lumborum arises from the last two ribs and the transverse processes of all the lumbar vertebrae. Insertion is by means of a narrow, flat tendon into the ventral side of the ilium near the sacro-iliac articulation.

M. gluteus externus arises by two heads, which fuse near the insertion. The anterior head, which is considerably smaller and slightly overlaps the posterior head, arises from the gluteal fascia; its fibers fail to reach the dorsal midline by about 80 mm. The posterior head arises from the spines of the posterior sacral and anterior caudal vertebrae. The insertion of the muscle is into the fascia of the anterior (not external) surface of the femorococcygeus.

M. gluteus medius is somewhat larger than the gluteus externus, and has the usual origin from the dorsal part of the gluteal surface

of the ilium as far back as the greater sciatic notch. Insertion is into the external and posterior surfaces of the greater trochanter.

M. gluteus minimus lies immediately beneath the gluteus medius, and is slightly less extensive than that muscle. The minimus shows

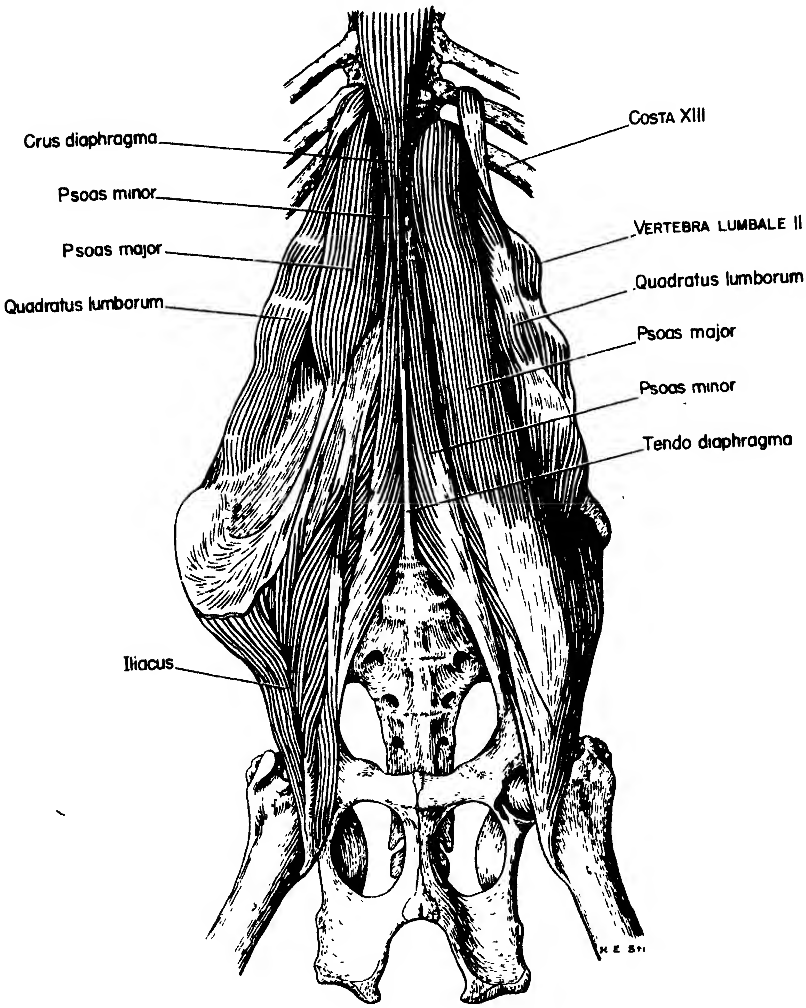

FIG. 20. Lumbar musculature, ventral view.

more or less of a division into four subequal bundles proximally. It arises from the ventral part of the gluteal surface of the ilium, and inserts into the anterior and external sides of the great trochanter.

M. gluteus ventralis is quite distinct from the gluteus minimus, beneath which it lies, with its anterior edge projecting beyond the

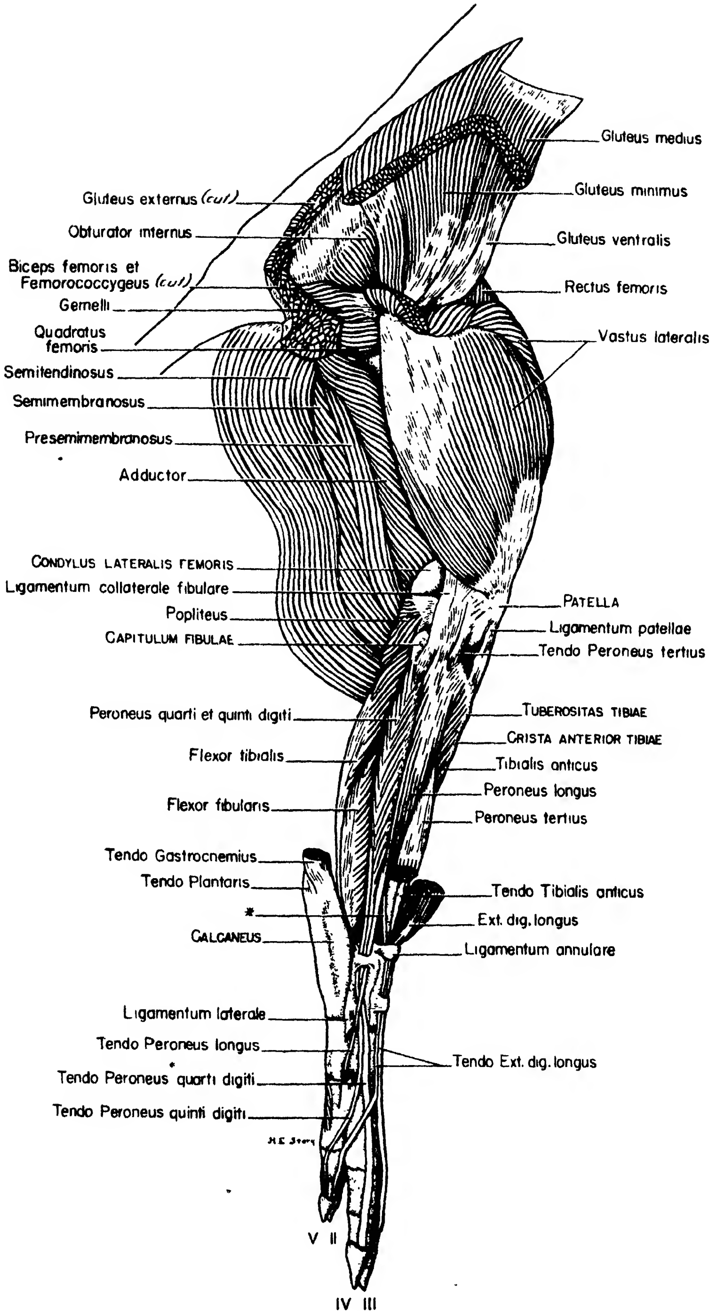

FIG. 21. Musculature of right thigh and hind leg, lateral view (*=tendon of extra muscle of peroneal group).

minimus. Origin is from the ventral border of the ilium, and insertion into the antero-internal side of the great trochanter.

M. gluteus profundus.—Four small muscles connecting the pelvis with the proximal end of the femur lie immediately caudad of and in the same plane as the gluteus ventralis. The first of these (the others are the obturator internus, the gemelli, and the quadratus femoris), lying just caudad of and in contact with the gluteus ventralis, apparently represents the gluteus profundus. It is a small muscle arising from the ilium above and in front of the acetabulum and inserting into the anterior surface of the femur mesad of the great trochanter.

M. tensor fasciae latae arises from the iliac crest, internally for about 60 mm. along the sacro-sciatic ligament, and externally from the fascia over the gluteus medius for some distance caudad of the iliac crest. The muscle spreads out in fan shape from its origin, becoming particularly heavy over the anterior edge of the thigh, and inserts into the fascia lata in a long curved line. The muscle fibers reach about two-thirds of the way to the patella.

Mm. gemelli.—The third and smallest of the four muscles on the same plane as the gluteus ventralis apparently represents the gemelli, although Windle and Parsons state that the gemelli are fused with the obturator internus in those animals in which the latter muscle arises outside the pelvis. The gemelli are represented by a single small independent muscle lying between the obturator internus and the quadratus femoris. It arises from the side of the ischium near the tuberosity, and inserts into the ventral part of the trochanteric fossa.

M. piriformis is apparently indistinguishably fused with the gluteus medius.

M. obturator internus (using Windle and Parsons' terminology; this is the externus of most authors) lies caudad of the gluteus profundus, which it scarcely exceeds in width. It arises from the ischium above and behind the acetabulum, and inserts into the trochanteric fossa.

M. obturator externus arises from the pelvic surface of the pubis and ischium and from the outer surface of the ischium laterad of the obturator foramen. No demarcation between the obturator externus and the "obturator tertius" of Windle and Parsons could be found. Insertion is into the trochanteric fossa laterad of the insertion of the obturator internus.

M. quadratus femoris is slightly narrower than the obturator internus. It arises from the ventral side of the ischial tuberosity and inserts into the posterior side of the proximal end of the shaft of the femur. It completely hides the distal end of the obturator externus.

Mm. semimembranosus et presemimembranosus are fused at their common origin, becoming separate only near their distal ends. Origin is chiefly from the tuber ischii, although the anterior fibers, including all the fibers going to the presemimembranosus, arise from the sacro-sciatic ligament. The presemimembranosus inserts into the internal condyle of the femur. The semimembranosus inserts into the head of the tibia, deep to the medial collateral ligament.

M. semitendinosus has a single head of origin, from the tuber ischii, where it is wedged in between the origins of the semimembranosus and biceps. It has the usual insertion into the inner side of the second quarter of the shaft of the tibia.

M. sartorius is a rather slender muscle arising from the inguinal ligament at about its middle and from the fascia covering the iliopsoas, and inserting by means of a long tendinous aponeurosis into the shaft of the tibia immediately below the knee. The muscle covers the femoral vessels throughout almost its entire length.

M. rectus femoris is entirely covered, except at its extreme proximal end, by the vastus lateralis. It arises, by a flat tendon common to it and the vastus intermedius, from the ilium in front of the acetabulum. Careful dissection failed to reveal a second head of origin, although Windle and Parsons state that they have not met with a single ungulate in which evidence of two heads could not be found. A few of the external fibers insert into the inner surface of the terminal tendon of the vastus lateralis; the main mass of the muscle inserts fleshily into the proximal border of the patella.

M. vastus lateralis is very extensive. It almost completely encases the rectus, except the medial side of the rectus, which lies against the vastus intermedius. Origin is from the great trochanter. Proximally the muscle shows a slight tendency toward bilamination. The anterior fibers form a wide tendon distally, which inserts into the proximal border of the patella. The more lateral fibers insert partly into the side of this tendon and partly into the lateral side of the patella.

M. pectineus is a rather small muscle arising from the transverse ramus of the pubis near the symphysis. Its lateral and medial

surfaces, which lie against adjacent muscles, are covered with glistening fascia. Insertion is into the distal two-thirds of the medial surface of the shaft of the femur.

M. gracilis is a very extensive flat muscle, covering the whole posterior half of the medial surface of the thigh. It arises from the entire pubic symphysis, and inserts by means of an extensive aponeurosis, which is continuous anteriorly with that of the sartorius, into the medial side of the tibia for nearly its entire length. The posterior fibers join the fascia that runs down to the tendon of Achilles.

M. adductor is composed of a single prismatic mass, which shows no tendency to separate into magnus, longus, and brevis. It arises, along the entire length of the symphysis, from the pubis and ischium. Insertion is into the distal two-thirds of the shaft of the femur.

M. biceps femoris arises from the tip of the ischial tuberosity, its origin wedged in between that of the femorococcygeus and that of the semitendinosus, and inserts into the fascia of the leg below the patella. As usual, a fibrous sheath passes down from its lower border to help ensheath the tendon of Achilles.

M. femorococcygeus is very large, considerably exceeding the biceps in size (fig. 14). Origin is exclusively from the ischial tuberosity, anterior to and opposite the origin of the semitendinosus, with the origin of the biceps embraced between. Thus the femorococcygeus and biceps lie in the same plane. As usual, the femorococcygeus and biceps are very intimately united. Insertion is into the side of the patella and into the fascia above and below the patella.

M. tenuissimus, as usual in ungulates, is either absent or blended so completely with the biceps that it is indistinguishable.

M. vastus intermedius is closely associated with the rectus femoris. It arises from the ilium in front of the acetabulum by a common tendon with the rectus femoris. It has no contact with the femur, its deep surface being separated from the bone by the great medial extension of the posteromedial edge of the vastus lateralis. It inserts extensively into the adjacent surface of the rectus femoris, none of its fibers reaching the patella.

M. vastus medialis (fig. 35) is the only muscle of the quadriceps extensor group that has any attachment to the femur. It is somewhat smaller than the vastus lateralis, and arises extensively from the entire length of the anterior and medial surfaces of the shaft of the femur. Insertion is into the distal end of the adjacent surfaces of the vastus intermedius and rectus femoris and into the medial side of the patella.

MUSCLES OF THE LEG AND FOOT

M. gastrocnemius arises by the usual two heads, from the femur just above each of the condyles. The medial head is considerably the larger. The two heads are distinct only near their origin, fusing almost at once and forming a stout tendon that inserts into the posterior part of the tendon of Achilles. As usual in ungulates, the tendon of the gastrocnemius and that of the plantaris are twisted around one another through 90°, so that the plantar tendon comes to lie externally (fig. 36).

M. plantaris is embraced by the lateral head of the gastrocnemius. It is a rather large muscle arising from the shaft of the femur above the external condyle. Its terminal tendon divides into four slips, which are distributed to the four digits. Vrolik also found four terminal tendons in the *Babirussa* material he studied; the tendon to the fifth digit is absent in other suids, so far as known.

M. soleus is usually described as wanting in the Suidae, and Vrolik so described it in the babirusas he dissected; Sisson, on the other hand, describes and figures it for the domestic hog. In the specimen at hand there is proximally a sharp separation between a wide mass of fibers on the external side of the leg and the adjacent part of the gastrocnemius. These two muscles are separated, in addition, by the large trunk of the common peroneal nerve, which passes between them. The lateral fibers, which apparently represent the soleus, arise chiefly from the head of the fibula, although their origin extends up onto the external condyle. There is also extensive origin from the lateral fascia of the leg, fibers coming from it for about the proximal third of the leg. Insertion is made extensively into the lateral side of the gastrocnemius tendon.

M. popliteus (figs. 21, 36) has the usual origin from the postero-internal surface of the external condyle of the femur, and inserts into the proximal half of the posterior surface of the tibia. The external fibers also insert extensively into the overlying fascia.

M. flexor tibialis (Flexor digitorum longus) is a slender muscle lying superficial to a part of the much larger flexor fibularis. It arises from the external surface of the tendon of the flexor fibularis, and thus has no relation whatever with the tibia. It forms a slender distal tendon, which joins that of the flexor fibularis at the level of the distal end of the tibia.

M. flexor fibularis (Flexor hallucis longus) is a comparatively large muscle. It has an extensive origin, from the posterior surface of the tibia, from practically the entire posterior surface of the

fibula, and from the intermuscular septa on either side of it. Its stout distal tendon divides into four slips near the distal end of the

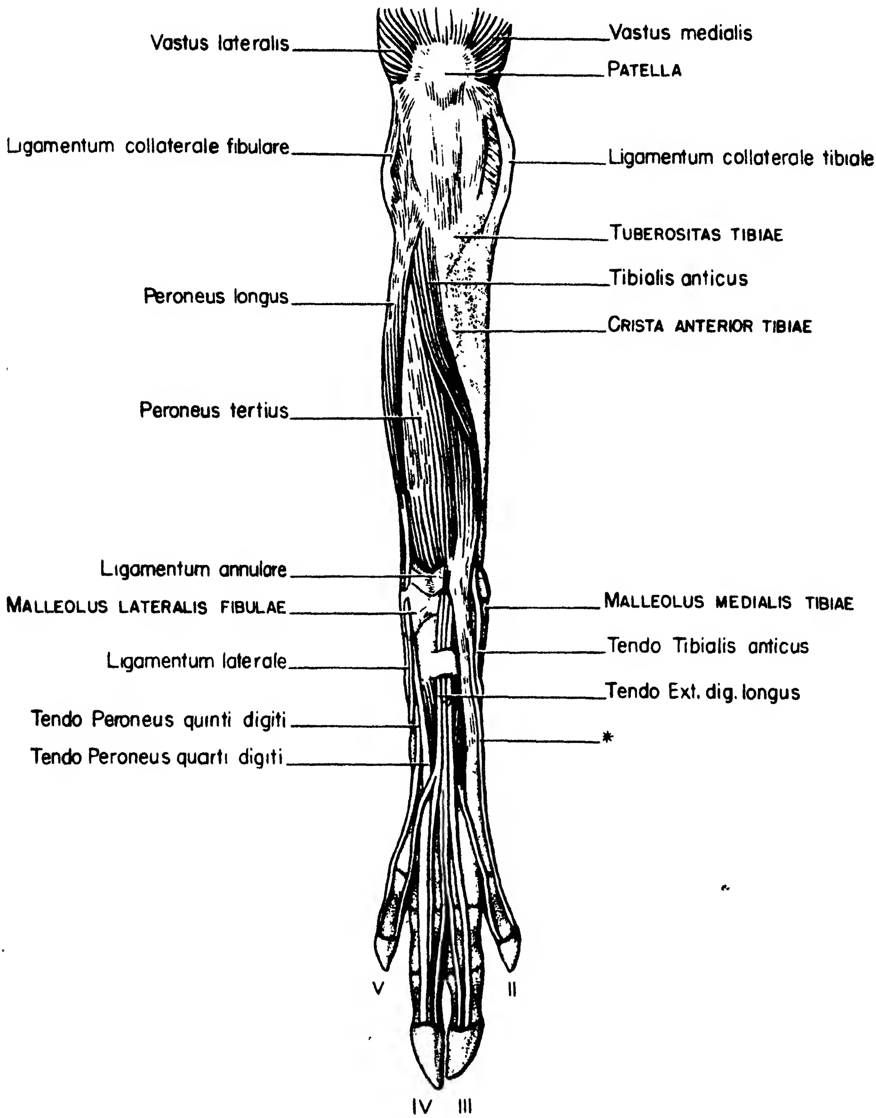

FIG. 22. Musculature of lower right hind leg, anterior view (*=tendon of extra muscle of peroneal group).

metatarsals, which are distributed to the four digits. As usual, the slips to the two middle digits are much stronger than the others.

M. tibialis posticus arises from the medial side of the posterior surface of the tibia along its entire length, the most proximal fibers

even reaching the head of the fibula. Its long and rather slender terminal tendon runs along the posterior side of the tendon of the flexor fibularis from the distal end of the calcaneum on, and although it partly unites with that tendon at the level of the tarso-metatarsal articulation, it becomes free farther distad and divides to form two tendons, which go to the middle toes.

M. tibialis anticus (the tibialis anticus of Windle and Parsons includes the peroneus tertius) is a rather slender muscle arising from the lateral surface of the tibia near its head. It terminates in a long slender tendon that accompanies the tendons of the peroneus tertius and extensor digitorum longus through an annular ligament at the distal end of the tibia, and inserts into the first cuneiform and metatarsal II.

M. extensor digitorum longus arises with the peroneus tertius from the external condyle of the femur, and is completely encased by that muscle on all but its deep surface, as far distad as the beginning of the terminal tendons. The extensor gives off three tendons. The most lateral of these divides again, sending one branch to digit V and one to digit IV. The middle tendon also divides, branches going to digit IV and digit III. The medial tendon goes only to digit III. This is the same tendon arrangement as Sisson gives for *Sus*, except that he records a third branch, which goes to digit II, from the lateral tendon.

M. peroneus longus arises from the lateral condyle of the tibia and the head of the fibula. Its anterior border is intimately attached to the anterior crural fascia. The muscle completely hides the proximal end of the peroneus tertius. Its terminal tendon passes across the distal end of the fibula and calcaneum, and beneath the lateral ligament through the aperture between the cuboid and metatarsal V, to the usual insertion on the first cuneiform.

Mm. peroneus quarti digiti et quinti digiti are fused to form a common muscle, which ends in two terminal tendons. The muscle arises from about the proximal two-thirds of the fibula. The two terminal tendons remain side by side as far as the metatarsals, then diverge to go to the fourth and fifth digits. That to the fifth digit is more slender, and arises somewhat higher than the other.

In addition to this common muscle there is another very slender muscle lying immediately in front of it that cannot be homologized with anything that I can find in the literature for any ungulate. This muscle is in contact with the tibia, along the crest that marks the juncture of its posterior and antero-external surfaces, and thus

lies very deep between the peroneus quarti et quinti digiti and the peroneus longus. It is separated from the peroneus longus by the peroneal nerve and branches of the anterior tibial artery, but is in very intimate contact with the peroneus quarti et quinti digiti. Origin is taken from the head of the fibula, in common with the latter muscle, and it terminates near the distal end of the tibia in a slender tendon, which passes beneath the tendon of the peroneus tertius, perforates it just distad of the tibio-astragular articulation, and continues to its insertion on the first phalanx of digit II (figs. 21 and 22,*). This tendon arrangement is reminiscent of the perforation of the tendon of the peroneus tertius by the tendon of the tibialis anticus in the Bovidae.

M. peroneus tertius (Pars femoralis of tibialis anticus, Windle and Parsons) completely covers the extensor digitorum longus, and is inseparably united to it proximally, becoming separable only near its distal end. The common origin of these two muscles is by a long round tendon from the front of the external condyle of the femur. The flat terminal tendon of the peroneus tertius inserts into the third cuneiform and the base of metatarsal III. The tendon is perforated by the slender tendon of a muscle associated with the peroneus quarti et quinti digiti, as described above.

SUMMARY OF MYOLOGICAL CHARACTERS

Of the 31 myological characters selected by Windle and Parsons in tabulating the results of their studies on the ungulates there are two with which the present study is not in agreement. (1) The records available to these authors indicated that M. coracobrachialis has two heads (medius and longus) only in the Cervidae and Bovidae among artiodactyls and that the longus is not always present even in these two families. Thus this character, although not constant, would tend to bracket off the Pecora from the remaining Artiodactyla, which invariably had a single head (the condition in the Giraffidae is unknown). The discovery of a second head in *Babirussa* shows that its presence is not limited to the Pecora. (2) M. obturator tertius was present in all artiodactyls of which Windle and Parsons had records. No structure corresponding to this muscle could be found in *Babirussa,* although I can speak with less certainty on this point than with respect to the coracobrachialis. It may have been overlooked, in spite of careful examination of the obturator externus.

In addition to these two general points, there are several others applying specifically to the Suidae. Although the myology of *Ba-*

birussa is typically suid in nearly all respects, the following characters represent departures from the suid pattern as hitherto known. Their significance, if any, cannot be assessed until other members of the family have been studied.

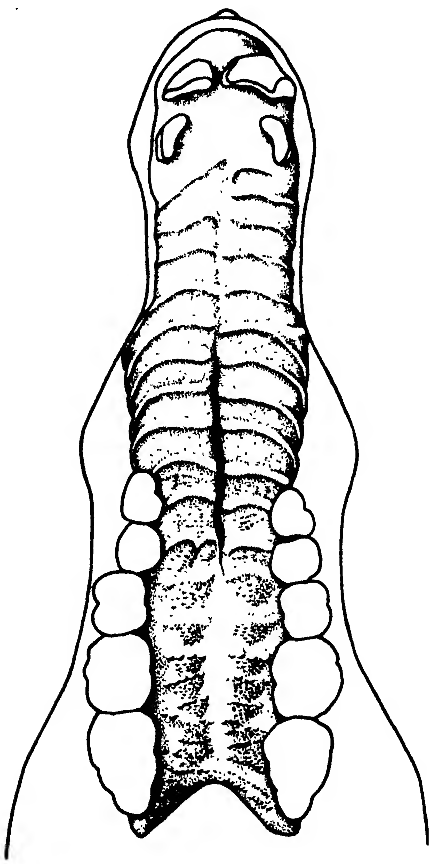

FIG. 23. Roof of mouth, showing appearance of hard palate.

(1) The middle slip of M. pectoralis profundus, which inserts into the tendinous intersection in the cephalohumeralis, is not known in other suids.

(2) M. brachialis inserts into the radius instead of the ulna (*Potamochoerus* and all other ungulates, Windle and Parsons) or the radius and ulna (*Sus*, Sisson).

(3) M. extensor digitorum communis has four bellies instead of the three normally found in *Sus*.

(4) M. extensor digitorum lateralis sends a tendon only to digit V, instead of to IV and V as in *Sus*.

(5) M. plantaris has four terminal tendons, instead of three as in other suids; this was true also in the babirusas studied by Vrolik.

(6) Mm. peroneus quarti digiti et quinti digiti are fused to form a common muscle with two terminal tendons, instead of remaining distinct.

(7) The presence of an extra muscle in the peroneal complex is a unique feature whose significance must remain uncertain until further studies and comparisons can be made.

DIGESTIVE SYSTEM

The *hard palate* (fig. 23) does not present any particularly noteworthy features. It is long and narrow, expanding somewhat at the level of the tusks. There is a well-marked median furrow, flanked on either side by about 22 transverse ridges. These are slightly convex anteriorly; the most posterior ones are much less pronounced and are crenulated. Posteriorly the space between the ridges is slightly tuberculated. The area enclosed by the incisors is devoid of ridges.

The *tongue* has the long, narrow form characteristic of ungulates. There is a prominent median glosso-epiglottic fold, bounded on either side by a well-marked depression.

The entire dorsum of the tongue is covered with a velvety mat of *conical papillae*. These are longer and denser on the so-called intermolar eminence anterior to the vallate papillae. *Fungiform papillae* are small, numerous, and quite evenly distributed over the dorsum of the tongue. They are absent on the ventral surface, but on the sides of the tongue at the level of the molars they become enormously enlarged. No *foliate papillae* could be found, but there is a pair of *vallate papillae* occupying approximately the same position as do those of *Sus*.

THE STOMACH

(Figs. 24, 32)

The stomach differs from that of the domestic hog chiefly in the enormous size of the diverticulum ventriculi, in the prominence of the constrictions that delimit its three main divisions, and in the size and complexity of the cardia. The stomach is large, measuring 880 mm. along the greater curvature, from the pylorus to the base of the diverticulum. It is much more elongate than that of *Sus;* this is true particularly of the cardia, which is continued beyond the entrance of the esophagus for a distance exceeding all the remain-

ing length of the stomach. The esophagus enters the stomach at an oblique angle, as in the domestic hog, although the angle is considerably less acute in *Babirussa*. The lesser curvature is 155 mm. in length. The fundus and cardia are abruptly reflected against each other at right angles to the greater curvature (fig. 24), and the pylorus in turn is reflected back against the fundus along the lesser

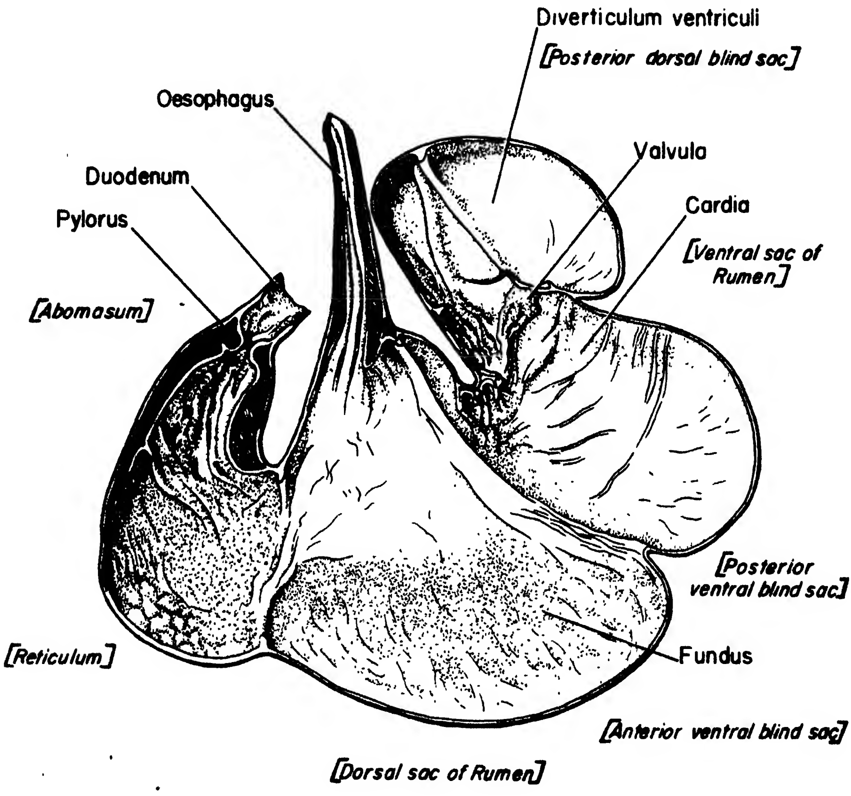

FIG. 24. Stomach sectioned and laid out flat. Regions corresponding to parts of the ruminant stomach are labeled in brackets.

curvature, so that the topographical relations of the parts of the stomach are very complex. The diverticulum is 165 mm. long and 135 mm. wide. It is completely encased in a snugly fitting fold of the lesser omentum, and in the normal position lies closely against the fundus.

The walls of the stomach are thin throughout, except in the pyloric region and at the mouth of the diverticulum along the lesser curvature. The wall of the cardia is only about 0.5 mm. thick in the region of the greater curvature; this is increased to 1.5 mm.

in the region of the lesser curvature. The wall in the fundus region is about 1 mm. in thickness. The pyloric wall is heavy, with a maximum thickness (along the lesser curvature) of 13 mm. The wall of the diverticulum has a maximum thickness of 3.5 mm., which is near its mouth along the lesser curvature; along the greater curvature it has a thickness of only 0.5 mm.

The lining of the esophagus is thrown up into longitudinal ridges near the stomach, and these are continued into the stomach lining for a short distance. The lining of the stomach is esophageal in character over a small area (40–50 mm. in diameter) around the entrance of the esophagus. The remainder of the stomach lining is rather devoid of macroscopic character, except in the pyloric region where it has a reticulated, honeycomb appearance.

In the dorsal half of the bisected stomach a prominent fold, corresponding to the reflection of the cardia upon itself, appears on the inner surface of the stomach. This fold, which is 25 to 30 mm. high, begins at the esophagus and runs diagonally across the dorsal wall of the stomach; it thus corresponds to the "left longitudinal groove" of veterinary anatomy in the ruminant stomach. A similar but much less prominent fold runs outward from about the center of the lesser curvature. There are no corresponding folds on the ventral wall of the stomach. The entrance to the diverticulum is guarded by a heavy muscular projection extending inward from the lesser curvature and a thin non-muscular fold extending inward 50 mm. from the greater curvature; these structures are not continuous with one another. Prominent rugae radiate from the former into the diverticulum and into the adjacent part of the cardia, while a low but well-defined fold runs from the latter completely around the wall of the diverticulum, dividing the cavity into subequal parts.

When seen in longitudinal section (fig. 24), the stomach of *Babirussa* presents striking similarities to a relatively simple ruminant stomach (e.g., the domestic sheep). Every part except the omasum, even including a rudimentary reticulum, is represented and occupies the same relative position. The arrangement is scarcely such that true rumination could take place, however, and it is certain that the similarity is due to convergence, and consequently is without much phylogenetic significance.

THE INTESTINES

(Fig. 34)

The *small intestine* is 5.5 meters (about 20 ft.) long, measured with the mesentery attached. This is five times the length of the

head and body, and thus agrees with the proportions found by Owen in *Phacochoerus*, while contrasting sharply with the great length (ten times head-and-body length) in the domestic hog. The duodenum, which is 370 mm. long (measured to the beginning of the mesentery of the jejuno-ileum), is a simple loop, as noted by Mitchell (1905). The posterior part of the colon curves around through this loop on its way to the pelvic canal. The bile duct enters the wall of the duodenum 15 mm. beyond the pylorus; the papilla is situated 25 mm. beyond the pylorus. The ampulla is 18 mm. in length, and its lining is raised into several faint longitudinal

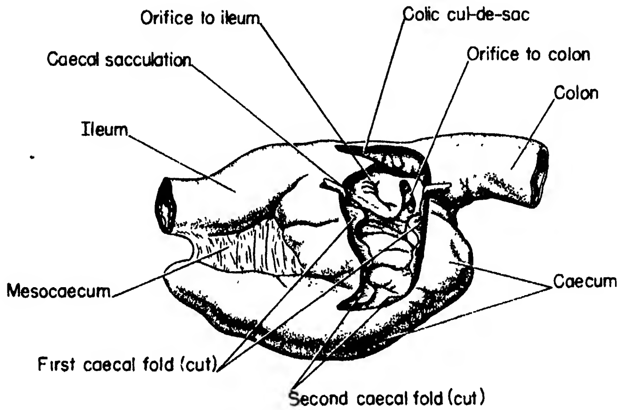

FIG. 25. Caecum, with wall opened to show internal structure.

folds. The jejuno-ileum is arranged in a series of tight loops around a rather narrow and somewhat crescent-shaped mesentery. This part of the intestine has a diameter of about 15 mm.

The *caecum* (figs. 25, 34) apparently agrees with the findings of Vrolik and Mitchell, although the descriptions and figures given by both these authors are inadequate. The caecum is composed of a large and rather complex proximal part and a simple conical terminal part. The ileum opens into the caecum at an oblique angle, its orifice guarded by a prominent valve. The colon is continued beyond the terminus of the ileum, so that the ileum and colon appear to overlap at this point. Thus the colon forms a cul-de-sac behind the terminal part of the ileum, but opens into the caecum by a simple orifice near the outlet of the ileum.

The proximal part of the caecum is divided into four sacculations by constrictions in its wall, which are associated with thickening of the wall itself. Thus the lining of this part of the caecum appears

to be thrown up into prominent folds. The terminal part of the caecum is a simple diverticulum, 65 mm. in length, which is reflected toward the ileum and held in place by a short fold of the mesocaecum. The diameter of the proximal part is about 40 mm., while that of the terminal part is only about 15 mm.

The *large intestine* is 3 meters (about 10 ft.) long, which is only three times the head-and-body length of the animal. This compares with four times given by Owen for *Phacochoerus;* it is also about four times in the domestic hog. Except for its terminal part it is arranged in the enormous double spiral coil that is characteristic of the Suidae. The terminal part arches craniad through the loop of the duodenum, then runs straight caudad along the midline to the rectum.

The spiral coil agrees with that of *Sus* in that the proximal (centripetal) part of the coil exceeds the distal (centrifugal) part in diameter. The difference between these two regions is much less striking in *Babirussa.* The centripetal part has a diameter of only about 20 mm., which exceeds that of the jejuno-ileum only slightly; the diameter of the centrifugal part is about 10 mm.

THE LIVER

(Fig. 26)

The liver weighs 1115 g. (preserved), which is only about half the weight of this organ in the domestic hog, but is almost exactly the weight of the liver in the *Phacochoerus* dissected by Owen (1119 g.). It measures 235 mm. in long diameter by 145 mm. in short diameter. The general arrangement and proportions of the lobes are similar to those in the domestic hog. The most notable difference is the much smaller size of both left lobes, particularly the left lateral, in *Babirussa;* this gives the liver a triangular appearance when viewed from either the diaphragmatic or the visceral surface. The fossa for the gall bladder is entirely in the right central lobe. The posterior vena cava runs along the surface of the caudate lobe, and is only partly embedded in its substance.

The *gall bladder* is a narrow, elongate structure, 55 mm. in length, almost completely embedded in the substance of the right central lobe. Its tip reaches the lateral margin of the liver, and in this it contrasts sharply with the gall bladder of the domestic hog. The cystic duct, which is smaller than the hepatic duct and 50 mm. in length, joins the hepatic duct at an acute angle just beyond the portal fissure. The opening of the ductus choledochus into the duodenum was described above.

The *pancreas* was damaged in removing the viscera from the body, and its structure and relations could not be determined.

The *spleen* (fig. 32) is a long, narrow organ, very loosely attached to the stomach by a long gastro-lienal ligament. The anterior end is triangular in cross section, and is wider than the posterior end,

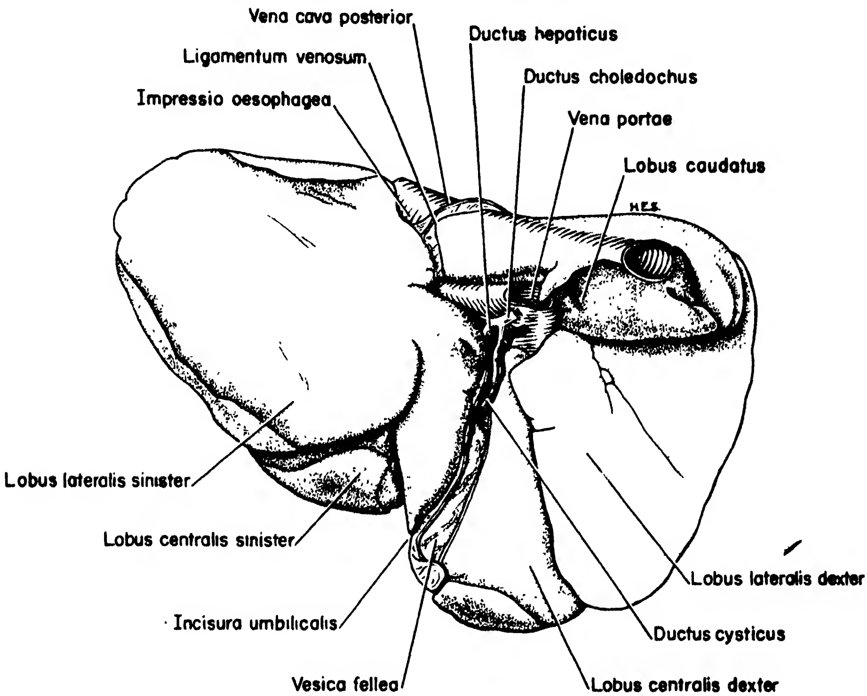

FIG. 26. Visceral view of liver.

which is thin and flat. The length of the spleen is 275 mm., and its maximum width at the anterior end is 65 mm.

SUMMARY OF DIGESTIVE CHARACTERS

The digestive system presents several unusual features, the significance of which it is difficult to evaluate without further knowledge of other members of the family.

(1) As has long been known, the stomach differs notably from that of other suids in its size and complexity. It exhibits a rather striking parallelism with a simple ruminant stomach. The significance of this is not clear, but the similarity is certainly due to convergence; the complex stomach of *Babirussa* is easily derived from the simple stomach of *Sus*. On the other hand, the stomach

of *Babirussa* seems to have little in common with that of the peccaries (cf. also below, under the celiac circulation).

(2) The small intestine agrees in length with that of *Phacochoerus;* in both it is strikingly shorter than in the domestic hog.

(3) The caecum appears to be not dissimilar from that of *Phacochoerus;* it is much smaller than that of the domestic hog.

(4) The large intestine is somewhat shorter than in either *Phacochoerus* or the domestic hog. *Babirussa* also differs from the domestic hog, at least, in the relatively small diameter of the centrifugal part of the spiral coil.

(5) The liver differs from that of the domestic hog in the small size of both left lobes and in the fact that the gall bladder is entirely in the right central lobe. The gall bladder is elongate, its tip reaching the margin of the liver instead of only about halfway, as in the domestic hog.

RESPIRATORY SYSTEM

The *larynx* (fig. 27) differs rather notably from that of the domestic hog in a number of features. The cricoid cartilage has a very long and rather narrow lamina, which projects backward beyond the origin of the arch. The anterior border of the lamina is produced in Λ-shape. The median ridge is elevated into a prominent keel, whose contour forms a smooth arch when the larynx is viewed laterally. The cricoid arch is very narrow antero-posteriorly, and is directed backward much more sharply than it is in the domestic hog. The thyroid cartilage is heavily calcified posteriorly; Vrolik states that it was almost completely ossified in both the old and young animals that he dissected. Its general form differs from that of the domestic hog only in details. Its posterior border is less curved when viewed laterally than it is in the domestic hog, due to the fact that the posterior cornu is not carried backward as it is in *Sus.* There is a shallow but distinct median notch in the anterior border. The arytenoid cartilages differ from those of *Sus* chiefly in the less conspicuous elongation of the apex; the narrow backwardly curving tip of the apex is absent in *Babirussa.*

The *epiglottis* is much smaller than that of *Sus,* and lacks the tri-lobed outline characteristic of this structure in the domestic hog. It is a narrow spout-like structure, with a distinct median notch in its anterior border. It resembles that of *Sus* in having the middle part of its base turned forward and resting on the thyro-hyoid

membrane, and in being closely attached to the hyoid bone by the hyo-epiglottic ligament and a strong hyo-epiglottic muscle.

The *trachea* is 168 mm. long and is composed of 27 incomplete rings. It has a diameter of 20 mm. A special bronchus to the right anterior lobe comes off the trachea at the level of the twentieth

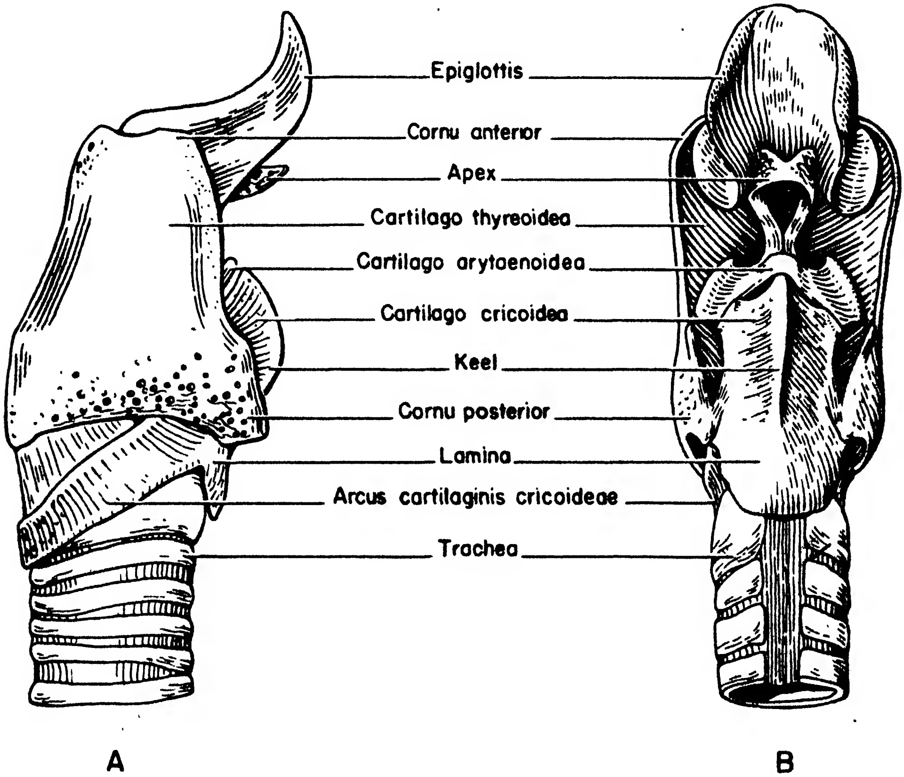

FIG. 27. Larynx; A, lateral, and B, dorsal views.

ring. The right bronchus bifurcates after about 20 mm.; the left first gives off a small bronchus to the anterior lobe, then divides, one of the resulting bronchi going to the anterior lobe, the other to the posterior lobe. The small bronchus to the azygos lobe comes off at the base of the bronchus to the right posterior lobe.

The *lungs* are asymmetrical, the right considerably exceeding the left in size. They are made up of incompletely separable lobes. The right lung is composed of three lobes. The large anterior lobe is subdivided, the anterior of its two divisions curving ventrad over the right auricle, as Garson described for *Porcula salvania;* this is also true in the specimen of *Tayassu* examined. The medial lobe

is very small and very incompletely separated from the other two lobes dorsally. The posterior lobe is the largest, and is extensively molded by the diaphragm posteriorly. The left lung is composed of two lobes—a chevron-shaped anterior lobe and a much larger posterior one that corresponds in shape to its mate on the opposite

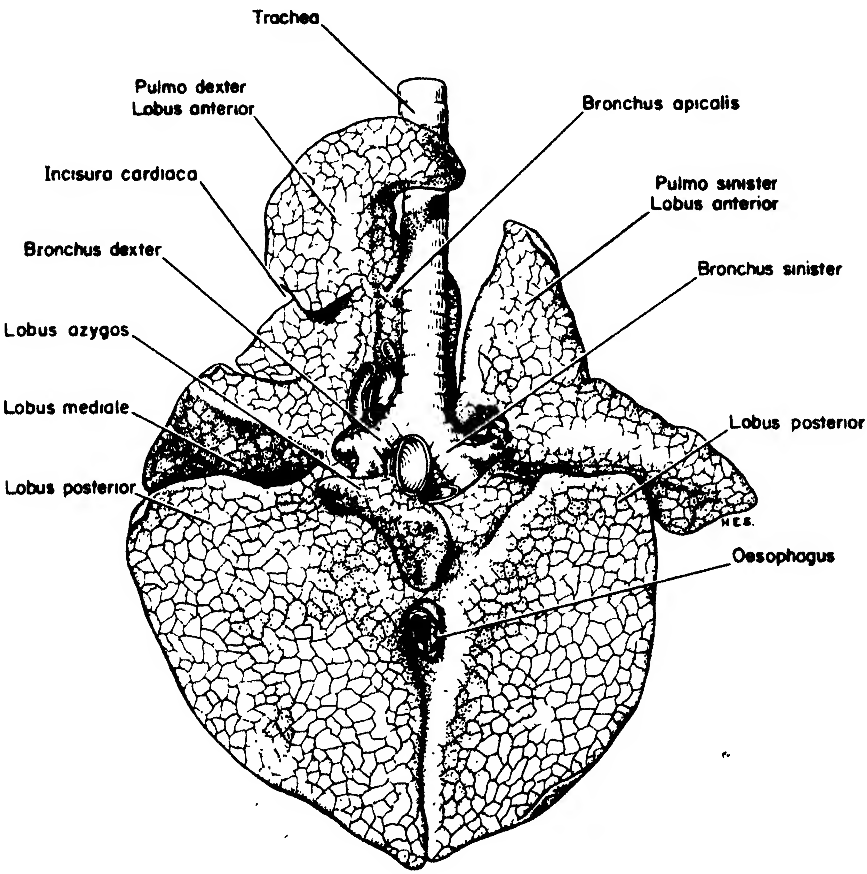

FIG. 28. Trachea and lungs, ventral view.

side. The azygos lobe is small, wedge-shaped, and situated along the midline.

KIDNEYS

The kidneys (fig. 31) are very asymmetrical, the right one measuring 132 mm. in length while the left is only 93 mm. The right kidney, which is apparently normal, is a flat bean-shaped structure, 68 mm. wide and 25 mm. thick. In form it is quite similar to that of the domestic hog.

The kidney structure is similar to that of the domestic hog. The hilum, which is 30 mm. wide, is situated slightly behind the middle of the inner border. The pelvis has the usual funnel shape, and divides into two major calyces as it does in the hog. Five pyramids, with wide and flattened papillae, are visible on a longitudinal section of the kidney. The renal artery bifurcates just before entering the hilus, one of the branches passing dorsad of the ureter while the other passes ventrad. The ureters are wide (15 mm. flattened out) and thin-walled. They pursue a rather tortuous course down to the bladder.

THE ARTERIES

No adequate account of the arteries in any member of the Suidae (including the domestic hog) is available to me. Such descriptions of the circulation of certain regions in the domestic hog as were available have been consulted, however, with the result that the following account is partly purely descriptive and partly critical. Apparently no one has hitherto examined the circulation in a non-domestic member of this family. Final evaluation of the characters afforded by the arteries must await much further work.

The animal died of a heart rupture, and the accumulation of coagulated blood in and around the heart rendered it unfit for study.

THORACIC AORTA

The arch of the aorta gives rise to two branches of nearly equal caliber: the innominate and the left subclavian. These leave the arch immediately beyond the heart, and are very close to one another at their origins.

A. anonyma is short. About 35 mm. beyond its origin it bifurcates to form the right subclavian and a smaller very short trunk that gives rise to the common carotids (fig. 29, B). Parsons (1902) recognized five types of arrangement of the aortic branches in ungulates, and he states that the Suidae of "all authors" belonged to type A (fig. 29). The two specimens of *Babirussa* dissected by Vrolik also belonged to this type. Thus the present specimen of *Babirussa*, which falls into type B, apparently offers the first exception among the Suidae.[1]

Each common carotid runs craniad alongside the trachea to the level of the larynx, where it divides to form the external carotid and a trunk from which the internal carotid and other posterior

[1] The aortic branches in the specimen of *Tayassu* studied were of the same type as those of our *Babirussa*, differing only in that the carotid trunk was greatly elongated (fig. 29, C).

cranial arteries arise. *A. thyreoidea anterior* arises from the ventral wall of the common carotid a few millimeters before the latter bifurcates. *A. laryngea* takes origin at the level of the bifurcation.

At its bifurcation the common carotid gives rise to a large lateral trunk from which the internal carotid, occipital, auricular, and superficial temporal arteries arise, and is continued craniad as the external carotid. *A. lingualis* arises from the medial wall of the external carotid a few millimeters craniad of the origin of the latter.

A. subclavia gives rise to four vessels. *A. mammaria interna* arises from the concave (posterior) side of the curve as the sub-

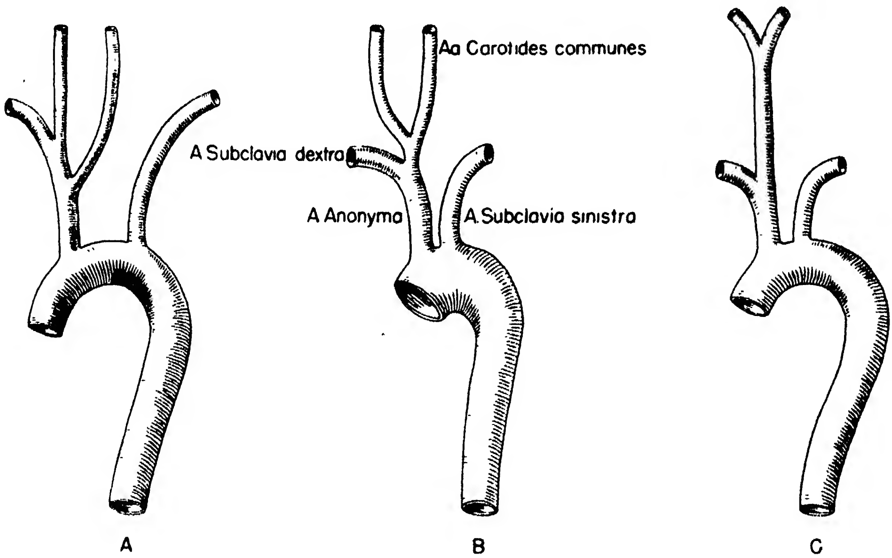

FIG. 29. Branches of aorta in suids. A, *Sus* (after Parsons); B, *Babirussa;* C, *Tayassu.*

clavian arches back toward the axilla. *A. thoracalis anterior* also arises from the inside of the curve, immediately beyond the origin of the internal mammary. The good-sized *Truncus costocervicalis* comes off from the outside of the curve directly opposite the origin of the internal mammary. It promptly breaks up to form several smaller vessels. *A. thyreocervicalis* comes off just beyond the costocervical trunk, and opposite the anterior thoracic.

If the axillary artery is regarded as that part of the main vessel of the foreleg that lies between the origin of the thyrocervical axis and the origin of the subscapular trunk, then in *Babirussa* the axillary is merely a short length of this trunk that gives origin to no vessels. *A. brachialis* accompanies the median nerve across the

medial side of the upper arm, terminating at the elbow by bifurcating to form the median and the recurrent radial arteries.

Truncus subscapularis (fig. 30), which arises at the distal end of the axillary, is as large as the brachial, or even exceeds it slightly in

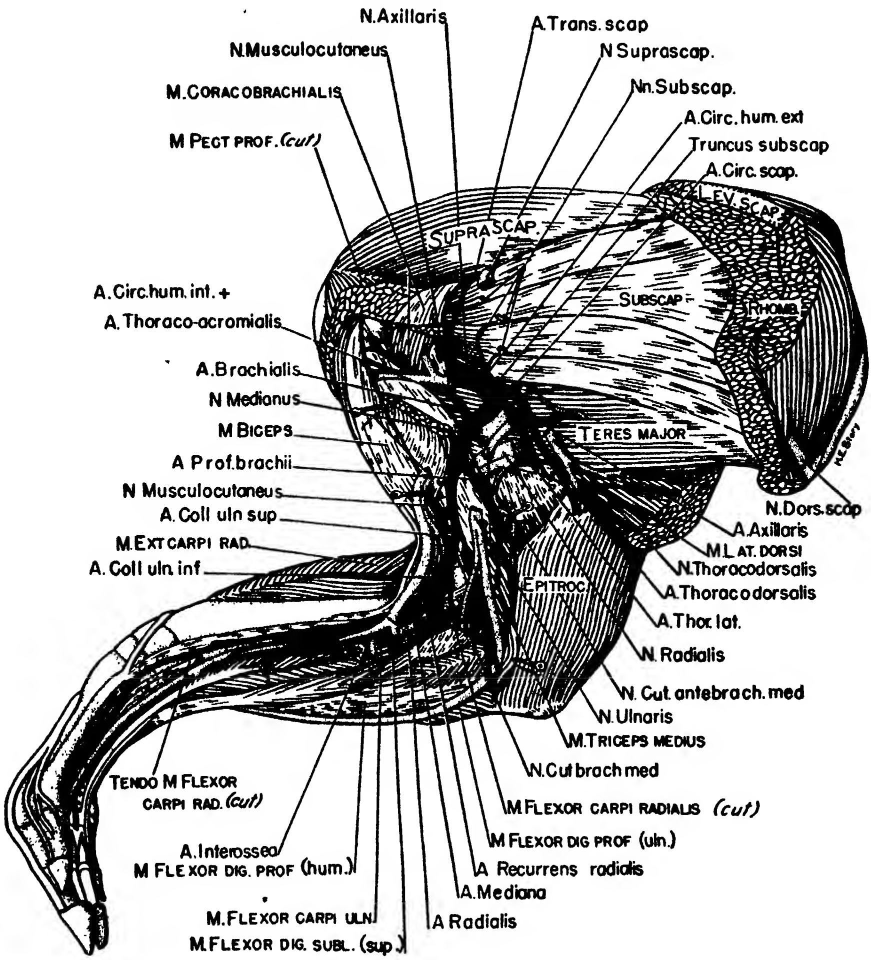

FIG. 30. Arteries and nerves of foreleg, medial view.

caliber. Thus the axillary appears to bifurcate to form these two vessels. The subscapular trunk curves upward and backward from its origin, giving rise to all the vessels of the shoulder region except the internal humeral circumflex. The arteries arising from the subscapular are as follows: (1) *A. transversa scapulae* (A. suprascapularis of veterinary anatomy) is a slender vessel arising from the anterior wall of the trunk near its base and running up between

the suprascapular and subscapular muscles. (2) *A. circumflexa humeri externa* (BNA: posterior) is a large vessel arising from the anterior wall a few millimeters beyond the transverse scapular. Passing ectad between the subscapular and teres major, it emerges on the external side of the shoulder between the medial and lateral heads of the triceps. (3) *A. circumflexa scapulae* is likewise a large branch arising from the same side of the trunk. It passes onto the infraspinous fossa of the scapula. (4) *A. thoracodorsalis* is the continuation of the trunk after several muscular branches have been given off.

A. brachialis gives rise to the following vessels in its course along the upper arm: (1) A good-sized vessel arises from the anterior wall of the brachial just distad of the origin of the subscapular trunk. This branch is referred to as the anterior (internal) humeral circumflex in veterinary anatomy, but apparently represents the combined *A. circumflexa humeri interna* and *A. thoracoacromialis* of human anatomy. It accompanies the bicipital branch of the musculocutaneous nerve between the heads of the coracobrachialis, supplying that muscle, the biceps, the pectorals, and some of the antero-external shoulder muscles. (2) *A. profunda brachii* is a large branch arising from the posterior wall of the brachial at the level of the ventral border of the teres major. (3) *A. collateralis ulnaris superior* is a slender branch arising from the posterior wall 25 mm. below the origin of the profunda brachii. (4) *A. collateralis ulnaris inferior* is a still more slender branch from the posterior wall at the elbow articulation. (5) Just below the inferior ulnar collateral, and immediately before the origin of the ulnar artery, the brachial gives rise to a small vessel that is the main source of a rete mirabile that encloses the median and ulnar arteries and the median nerve. This rete is apparently quite similar to that described by Hyrtl for *Phacochoerus* (Leche and Göppert, 1905). (6) A branch from the root of the rete just described runs down the forearm, along the anterior border of the tendinous band representing the pronator teres, to the carpus. This vessel, which is considerably more slender than the median artery, represents the *A. radialis*. (7) A good-sized *A. recurrens radialis* arises from the brachial just below the origin of the rete. It passes, as usual, beneath the distal end of the biceps to supply the extensor muscles of the forearm. Beyond this point the main trunk becomes the median artery. (8) The usual small muscular branches arise from the anterior wall of the brachialis.

A. mediana accompanies the median nerve along the volar side of the forearm, dividing at the distal end of metacarpal III to form

the digital arteries. *A. interossea* arises from the deep surface of the median just beyond the tendon of the biceps, and immediately enters the usual opening into the space between the ulna and radius.

ABDOMINAL AORTA
(Fig. 31)

The abdominal aorta runs along the midline, with the posterior vena cava lying to the right of it. It gives rise to the usual visceral

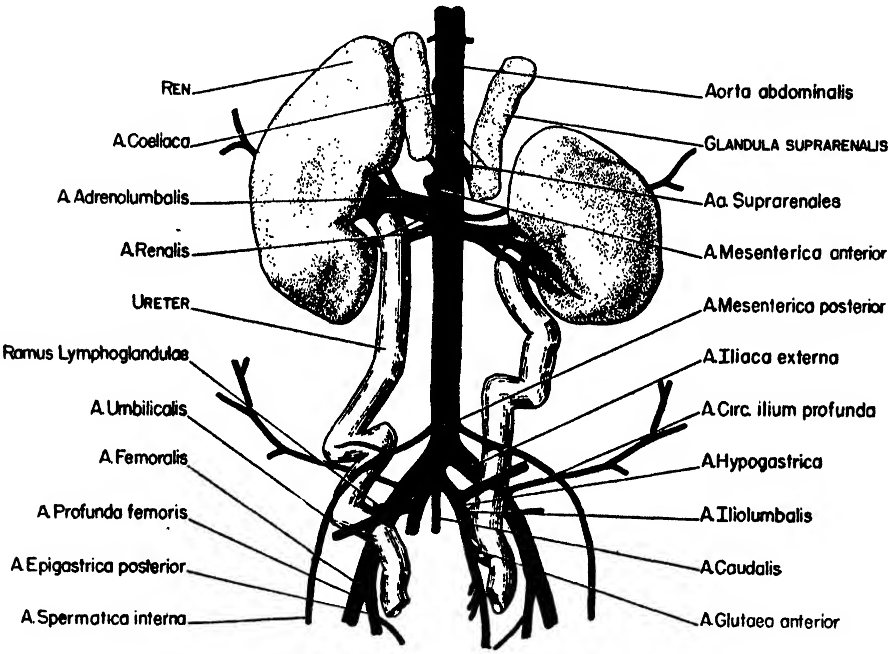

FIG. 31. Abdominal aorta and its branches.

branches before breaking up at the level of the lumbo-sacral articulation to form the terminal aortic branches.

A. coeliaca (Figs. 31, 32) arises from the ventral wall of the aorta at the level of the second lumbar vertebra, which is 50 mm. beyond the emergence of the aorta from the diaphragm. The celiac is a very short trunk, breaking up 10 mm. beyond its origin to form the usual three vessels: hepatic, splenic, and left gastric. These vessels arise from a common center.

(1) *A. hepatica* passes craniad beside the portal vein to the liver. Near the origin of the duodenum it gives off a large right gastroepiploic, which in turn gives rise to the anterior pancreatico-duodenal at the origin of the duodenum; the gastroepiploic continues along

the pylorus onto the ventral side of the stomach, where it anastomoses with the left gastroepiploic. The hepatic artery itself continues toward the liver, giving off a small cystic branch and a large right gastric branch and dividing in the portal fissure into four branches that supply the liver; this conforms closely to the description given by Sisson (1910) for the domestic hog. A small anastomotic twig from the base of one of the hepatic branches runs down and joins the left gastric.

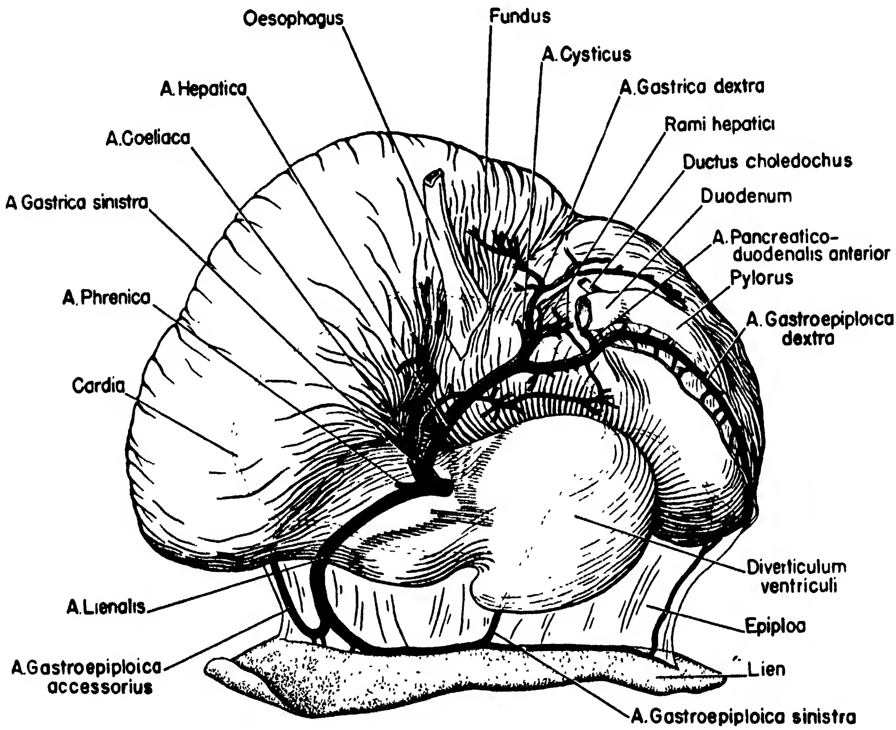

FIG. 32. Dorsal view of stomach, showing celiac circulation.

(2) *A. lienalis* runs across the neck of the caecal appendage of the stomach to the head of the spleen. Immediately beyond its origin it gives rise to (a) *Aa. phrenicae,* which take origin as a common trunk that bifurcates at once. Just before entering the hilus of the spleen the splenic artery divides to form two vessels almost equal in caliber. One of these apparently represents the small vessels that Sieber called the Rr. gastrici of the spleen. It arches around to reach the ventral surface of the cardia, gives off a large branch that supplies the diverticulum, then continues across the fundus to meet the right and left gastroepiploics in a common junction near the

beginning of the pylorus. This vessel, which is here called (b) *A. gastroepiploica accessorius*, is obviously a neomorph to supply the greatly enlarged fundus, cardia, and diverticulum.[1] (c) *A. lienalis* proper runs along the hilus of the spleen, giving off (d) *A. gastroepiploica sinistra* near the middle of the spleen. (e) A small

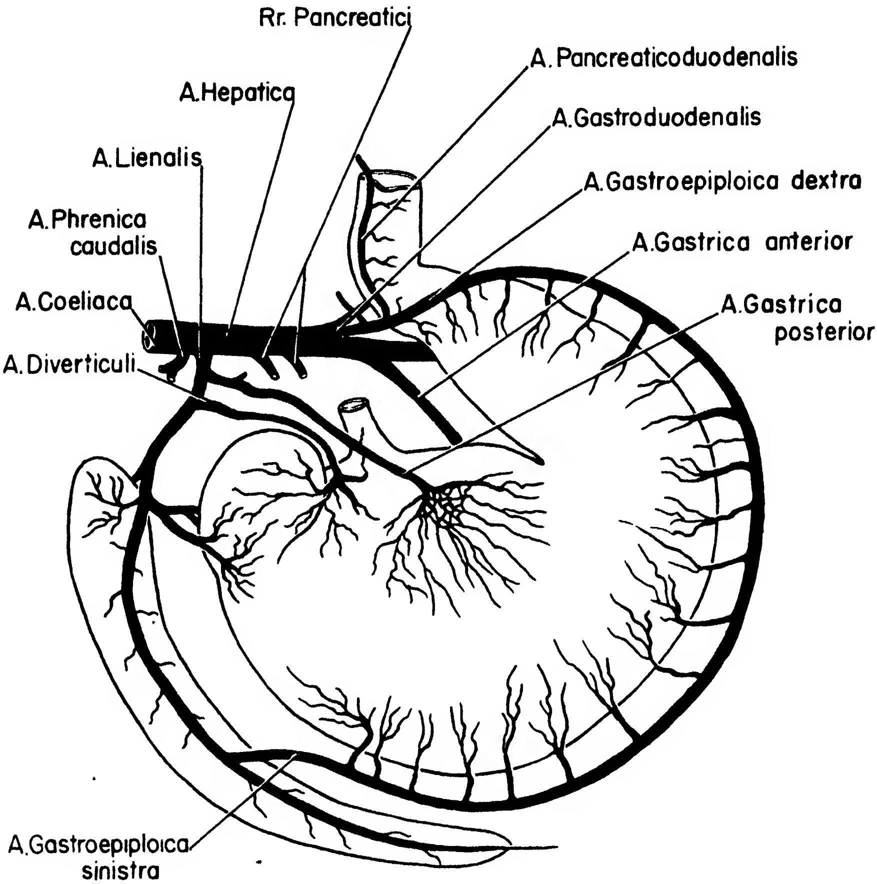

FIG. 33. Celiac circulation in the domestic hog (after Sieber).

anastomotic branch leaves the splenic in the tail of the spleen, to join the right gastroepiploic near the base of the pylorus.

(3) *A. gastrica sinistra* follows the lesser curvature, giving off numerous twigs to the cardia in this region; its terminus anastomoses with the hepatic where that vessel breaks up to form the hepatic rami.

[1] It may be noted that both the cardiac diverticuli in *Tayassu* are supplied by branches of A. gastrica sinistra, which indicates that the posterior diverticulum is not homologous with the diverticulum found in suids, as has been suggested.

A. mesenterica anterior (Figs. 31, 34) arises from the ventral wall of the aorta 40 mm. caudad of the celiac artery, at the level of the third lumbar vertebra. It runs across the mesentery in a very gentle arc whose distal end completely fails to loop back upon itself. According to Mitchell (1905) it does loop back in most mammals (including *Sus* and *Phacochoerus*), but the excellent X-ray photograph of an injected anterior mesenteric presented by Latarjet and Forgeot (1910, pl. 13) shows that the distal end of this vessel does not do so in the domestic hog.

The mesenteric gives rise to the following branches: (1) *A. colica media* (colica dextra+colica media of Sieber) arises from the convex side of the arc 13 mm. beyond the base of the mesenteric. The main part of the vessel passes down through the mesentery of the spiral coil along with the much larger anterior colic, supplying the smaller (centrifugal) coils of the colon; near the distal end of the spiral coil it anastomoses with the anterior colic. A small branch comes off near its base and passes along the straight terminal part of the colon, to anastomose with the posterior colic. (2) *A. pancreaticoduodenalis posterior* (Rr. pancreatici of Sieber) arises from the concave side of the arc immediately opposite the middle colic. (3) *A. colica anterior* (R. colicus of ileo-caeco-colica of Sieber) and (4) *A. ileocolica* (R. ileo-caecalis of Sieber) arise by a short common trunk from the concave side of the arc 30 mm. beyond the posterior pancreatico-duodenal. The anterior colic furnishes the blood supply to the large (centripetal) coils of the colon; the main vessel runs down through the spiral coil, giving off innumerable fine twigs to the intestinal wall. These twigs inter-anastomose to form a rete mirabile similar to that formed by the Aa. intestinales on their way to the small intestine. The ileocolic supplies the caecum, sending off in addition a fine anastomotic branch to the distal end of the mesenteric arc. (5) *Aa. intestinales* arise from the convex side of the arc and pass through the mesentery to the intestinal wall. An extensive and extremely fine rete is formed in these vessels between the mesenteric artery and the intestine. This extraordinary rete is practically identical with that found in the domestic hog (Latarjet and Forgeot, 1910, pl. 13), in which it has long been known as a unique structure. Its occurrence in *Babirussa* suggests that it may characterize all members of the Suidae.[1]

Aa. suprarenales, paired, are given off from the lateral walls of the aorta a few millimeters in front of the renals, and even slightly

[1] A similar rete was found in *Tayassu*.

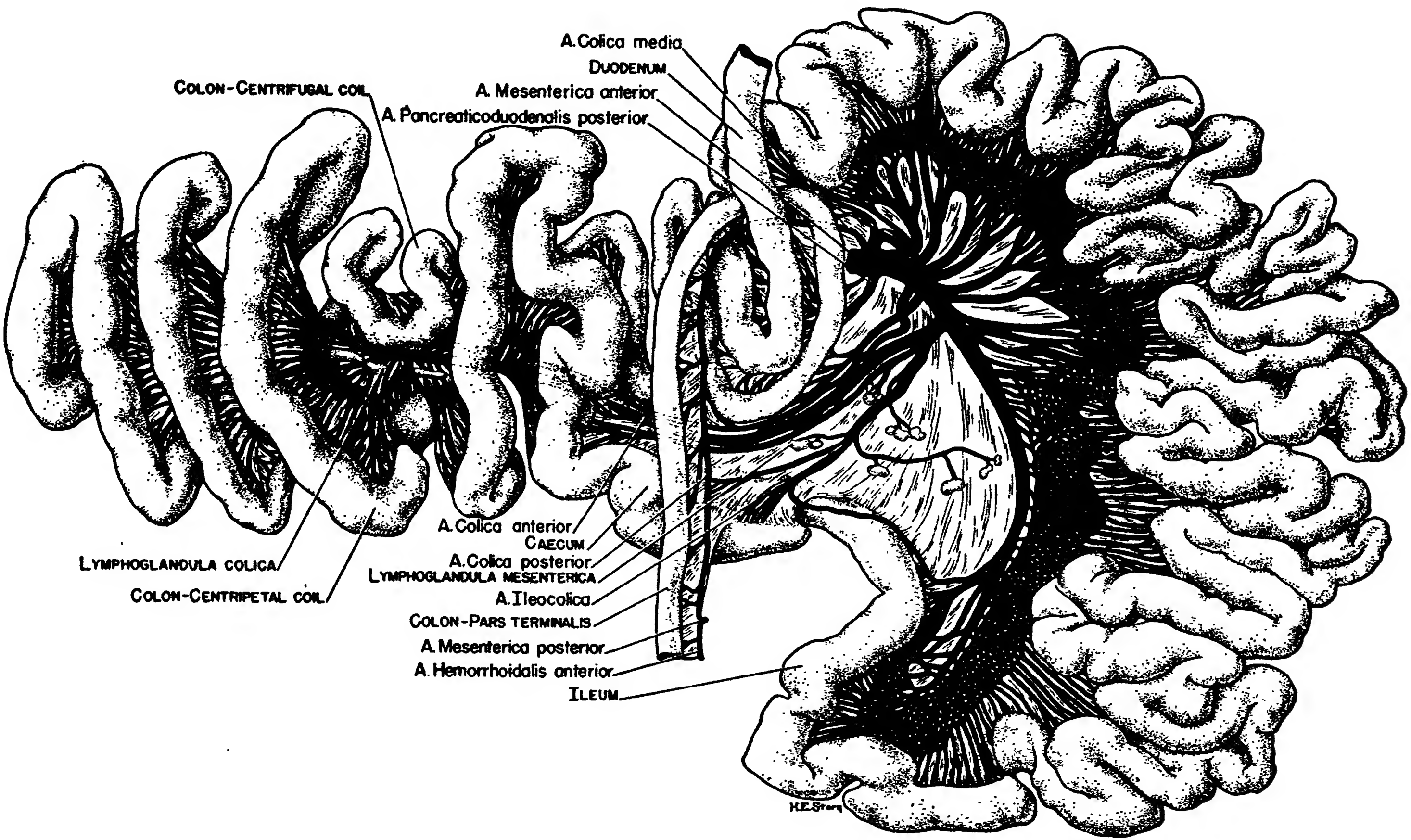

FIG. 34. Mesenteric circulation. The coils of the intestines have been spread apart somewhat.

craniad of the anterior mesenteric. There are two vessels, separated by a considerable distance, on the right side of the body; on the left side these arise from a common trunk.

Aa. phrenicoabdominales (Sieber) are a pair of fine vessels arising from the lateral walls of the aorta immediately anterior to the renals. Each passes straight laterad, bifurcating after about 10 cm. to form phrenic and abdominal rami.

Aa. renales arise immediately below the anterior mesenteric. The right comes off somewhat higher than the left. Each bifurcates a short distance (15 mm.) beyond its origin, the two resulting vessels breaking up into smaller branches before entering the kidney.

A. mesenterica posterior is a small vessel arising from a trunk common to it, the left spermatic, and the caudal artery (Fig. 31). This small trunk arises from the ventral midline of the aorta 25 mm. before its bifurcation to form the external iliacs; and the posterior mesenteric comes off a few millimeters beyond its origin. The posterior mesenteric bifurcates almost immediately to form the posterior colic and anterior haemorrhoidal arteries. *A. colica posterior* arises from the posterior mesenteric near its origin and follows the terminal straight part of the colon craniad, sending numerous twigs to it, and finally anastomosing with a branch of the colica media. *A. haemorrhoidalis anterior* is the caudal continuation of the posterior mesenteric after its bifurcation; it slightly exceeds the posterior colic in caliber.

Aa. spermaticae internae come off somewhat asymmetrically. The right arises independently beside the trunk referred to above, while the left arises from the trunk itself, near its origin. Each arches backward to the abdominal inguinal ring, through which it passes.

A. caudalis (sacralis media) arises from the bifurcation of the aorta in all cases of which I can find record.[1] In the present animal, however, it is the continuation of the above trunk into the tail. This is doubtless an individual anomaly.

About 20 mm. beyond the origin of the posterior mesenteric-caudal trunk, at the level of the lumbo-sacral articulation, the aorta bifurcates to form the external iliacs. A very short, slightly asymmetrically placed hypogastric trunk is continued caudad beyond this. The hypogastric trunk divides almost immediately to form the hypogastric arteries.

A. hypogastrica runs caudad along the roof of the pelvic cavity, gradually diverging from the midline and decreasing in size as

[1] This vessel was completely absent in the specimen of *Tayassu* examined.

branches are given off. It was not traced beyond the anterior border of the symphysis. *A. umbilicalis* arises from its external wall

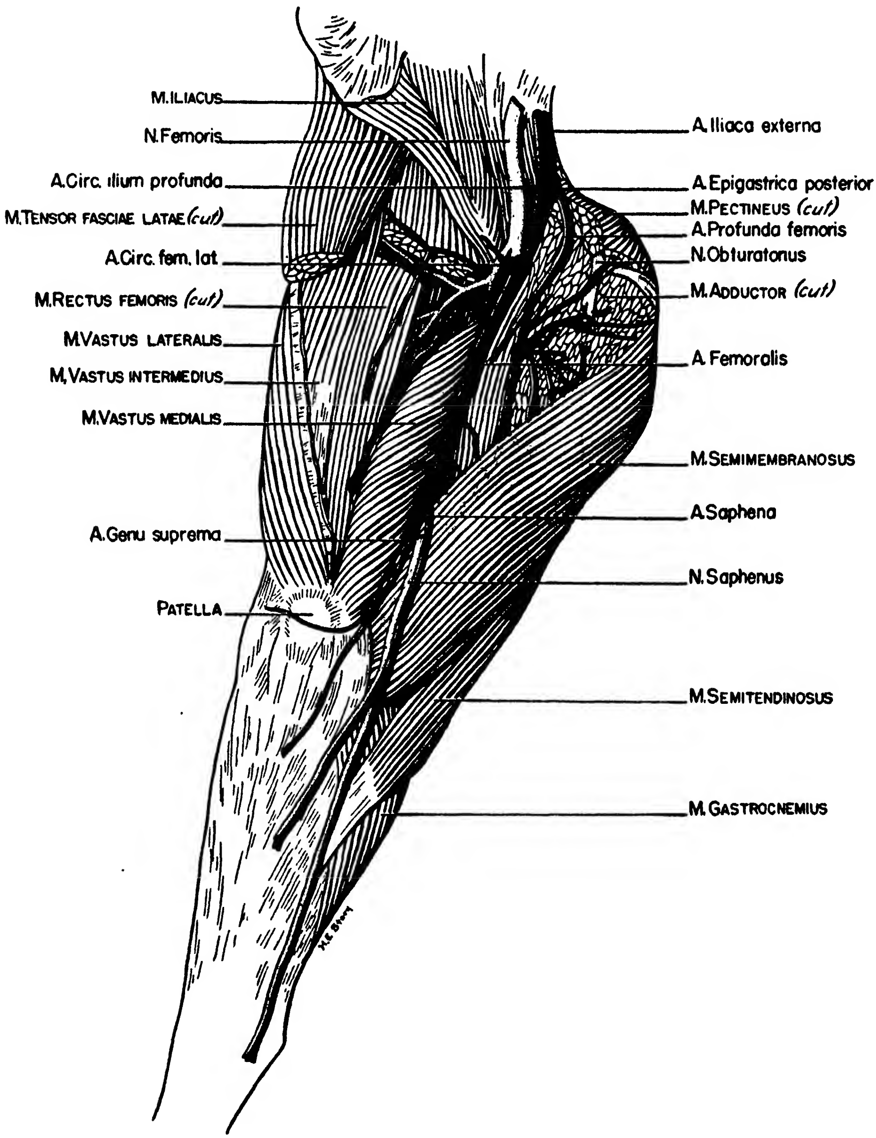

FIG. 35. Arteries and nerves of thigh, medial view.

immediately beyond its origin, and the small *A. iliolumbalis* arises similarly a few millimeters beyond. A pair of small vessels, representing *A. glutaea anterior*, come off from its external wall 20 mm. farther caudad, at the level of the great sciatic notch. Several small twigs,

of uncertain homology, are given off beyond this, and the hypogastric continues back into the pelvic cavity as a vessel of considerable size.

A. iliaca externa (figs. 31, 35), as usual, considerably exceeds the hypogastric in caliber. About 30 mm. beyond its origin it gives off the small *A. circumflexa ilium profunda,* which runs laterad across the psoas muscles, accompanied by two veins, to the body wall. Another small twig arising just beyond the circumflex iliac supplies a large iliac lymph gland. About 10 mm. before reaching the body wall the external iliac gives off the *A. profunda femoris* from its medial wall, and beyond this itself takes the name *A. femoralis.*

A. profunda femoris passes out onto the medial surface of the thigh, first giving off the *A. epigastrica posterior* within the abdominal cavity. On the thigh the deep femoral lies successively beneath the pectineus, adductor, and semimembranosus, giving off numerous twigs to the flexor muscles of the thigh. Near the middle of the thigh it emerges from beneath the semitendinosus and continues distad with the V. saphena parva and N. ischiadicus.

A. femoralis gives off small twigs to the iliacus and psoas muscles before leaving the pelvic cavity. Within the femoral triangle it gives rise to the large *A. circumflexa femoris,* which immediately breaks up to form branches to the extensor muscles of the thigh. About two-thirds of the distance down the thigh the femoral artery gives off the *A. saphena,* which accompanies the saphenus nerve distad on the medial side of the leg. Immediately below the saphena the smaller *A. genu suprema* is given off to the knee. These two vessels pass external to the semimembranosus, while the femoral artery itself continues across the popliteal space as *A. poplitea,* which breaks up between the femoral condyles to form the vessels of the leg.

A. poplitea gives rise to the following eight branches (fig. 36):

(1) *A. genu superior medialis* arises from its medial wall above the medial condyle. (2) *A. genu media* arises from the same side of the popliteal, 15 mm. farther distad. (3) *Aa. surales* are represented by three branches from the lateral side of the popliteal. The first of these (*A. femoris posterior* of veterinary anatomy) supplies the lateral head of the gastrocnemius, the second its medial head, and the third the soleus. At the proximal border of M. popliteus the popliteal artery breaks up to form five branches that run distad onto the leg. These are (4) *A. genu inferior medialis,* which is a slender vessel passing deep to M. popliteus; (5) *A. tibialis posterior,*

which runs beside the peroneal artery external to M. popliteus, accompanied by the tibial nerve; (6) *A. peronaea;* (7) *A. tibialis anterior,* which runs deep to M. peroneus, and is the largest branch

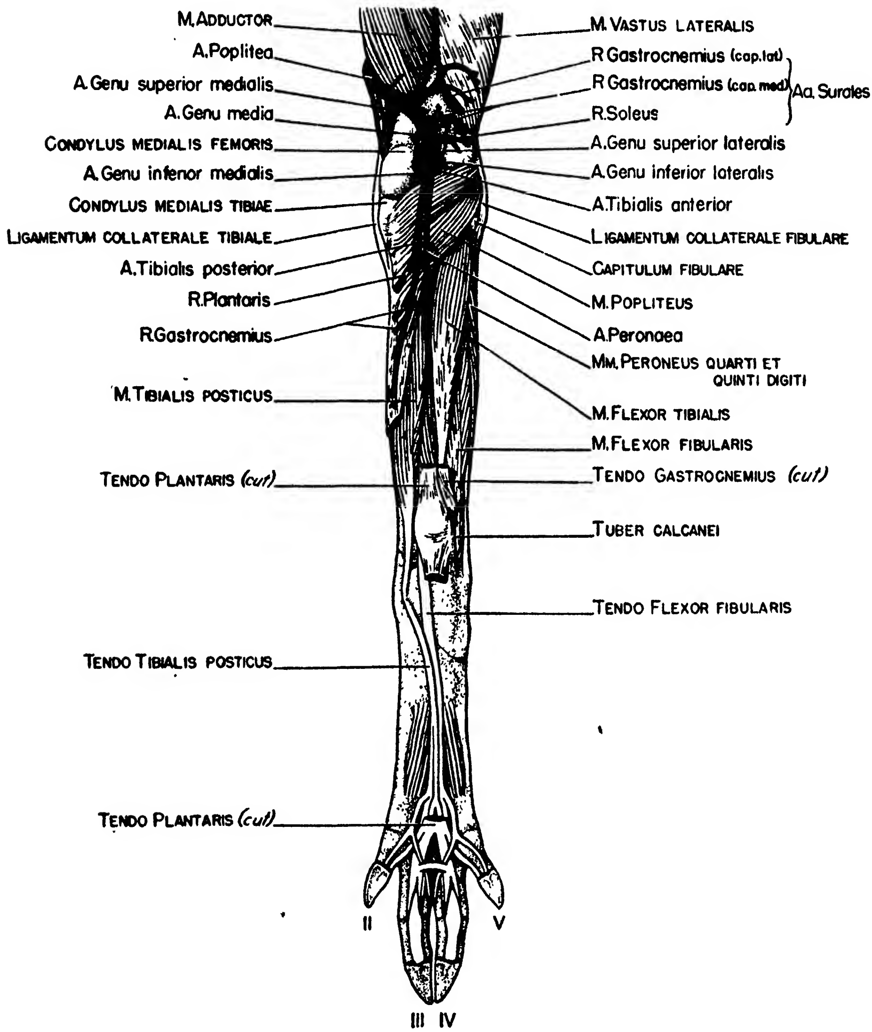

FIG. 36. Arteries of lower right hind leg, posterior view.

of the popliteal artery; it passes deep to the fibula, gives off the anterior recurrent tibial artery, and continues beneath M. tibialis anterior; (8) a short trunk that gives rise to *A. genu superior lateralis* and *A. genu inferior lateralis.* Unfortunately the injection was not complete enough to permit tracing the vessels into the foot.

THE BRACHIAL PLEXUS

(Fig. 37)

The brachial plexus is derived from the fifth to eighth cervical and first thoracic nerves.

N. cervicalis V gives slightly less than the posterior half of its substance to a loop that passes back to C6. *N. phrenica* arises from this loop, so that all of its fibers come from C5.

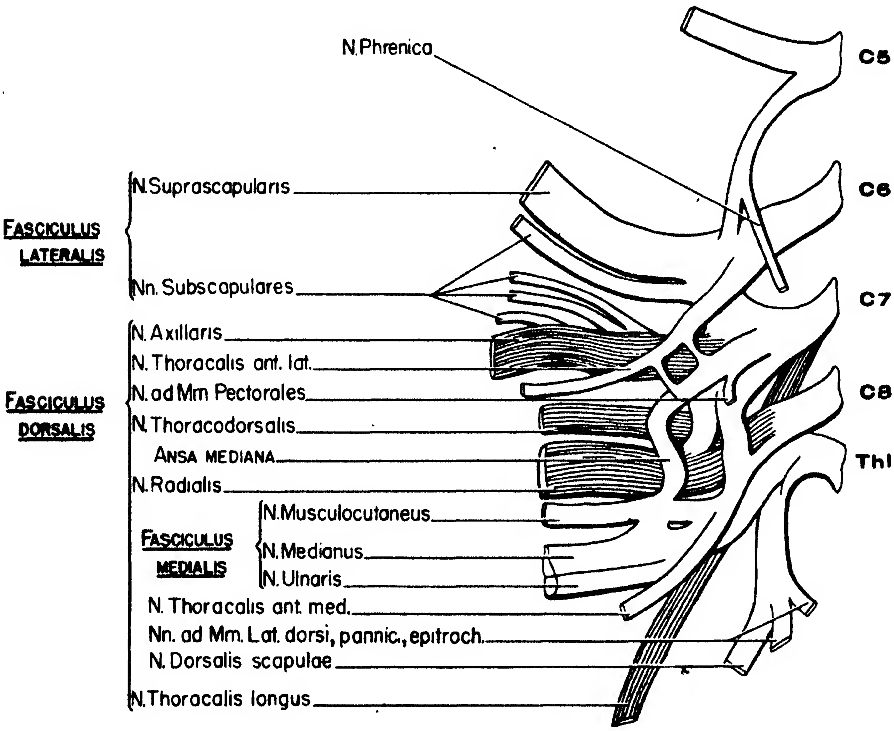

FIG. 37. Right brachial plexus, ventral view.

N. cervicalis VI gives most of its substance to the formation of a very large suprascapular nerve. Posteriorly it forms an extremely stout communicating branch with C7, which gives rise to one of the subscapular nerves. Immediately proximad of this communicating branch C6 gives off a branch which, after receiving two short communicating branches from the ansa mediana, becomes the *N. thoracalis anterior lateralis*.

N. cervicalis VII gives most of its substance to the formation of *N. axillaris*. In addition, however, it gives off the following four branches: (1) *N. thoracalis longus* arises from its dorsal side near its

emergence from the cervical foramen. (2) The anterior root of the *ansa mediana* arises from its ventral surface distad of the foregoing. (3) A root of *N. radialis* arises from its posterior border. (4) Immediately proximad of (3) a communicating branch with Th1 arises.

N. cervicalis VIII gives most of its substance to the formation of *N. radialis.* Its anterior fibers form *N. thoracodorsalis,* and its posterior fibers form a short communicating branch that joins the communicating branch from C7.

N. thoracalis I forms *N. musculocutaneus, N. medianus,* and *N. ulnaris,* the musculocutaneus and median nerves being augmented by fibers from the ansa mediana. *N. dorsalis scapulae,* from which branches arise that supply the latissimus dorsi, the panniculus, and the epitrochlearis, is formed by the posterior fibers of the first thoracic.

CONCLUDING REMARKS

The extremely scanty nature of our knowledge of the soft anatomy of the Suidae makes it impossible to draw far-reaching conclusions from the present study. In general it may be said that the results of the renewed examination of *Babirussa* emphasize the compactness of the family. This is particularly true of the musculature, in which this genus, with a few striking exceptions, exhibits all the peculiarities of the Suidae.

Externally *Babirussa* is the most aberrant of the living pigs, and it differs internally in a number of features, some of which may prove to be significant. The presence of four terminal tendons on M. plantaris as a unique feature among the suids that have been studied is suggestive, since the tendon to digit V could hardly be redeveloped once it was lost. This is true also of the complex structure of M. extensor digitorum communis. The presence of a second head in the coracobrachialis shows a fundamental difference from known suids, and study of other members of the family may show it to be of prime importance. The complex stomach, with its apparent convergence with the stomach of ruminants, cannot be interpreted on the basis of available data. Conspicuous differences between the larynx of *Babirussa* and that of *Sus* suggest that study of this organ in other suids might yield interesting results.

The anatomy of the Suidae can be discussed intelligently only after the outstanding genera have received adequate study, and it is obvious that such knowledge would become extremely important as a check on and a complement to the phylogeny indicated by the

fossil material (see Colbert, 1935; Pearson, 1928).[1] Data on intestinal length and liver size in wild races of *Sus* are needed, since both of these are enormously greater in the domestic hog than in any known wild pig. The musculature cannot be regarded as known until it has been studied in such forms as *Phacochoerus*, *Potamochoerus*, and *Hylochoerus*. Finally, competent study of the anatomy of the peccaries would probably aid materially in interpreting the anatomy of the typical Suidae and their degree of relationship to the peccaries (cf. Colbert, 1935; Pearson, 1923).

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STUDIES OF THE ANATOMY OF THE EXTRAHEPATIC BILIARY TRACT IN MAMMALIA

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STUDIES OF THE ANATOMY OF THE EXTRAHEPATIC BILIARY TRACT IN MAMMALIA

BY STEWART CRAIG THOMSON[1]

In a study of the extrahepatic biliary tracts of twenty common domestic and laboratory animals, Mann, Brimhall, and Foster (1920) called attention to the inadequate knowledge of this field of comparative anatomy. They recognized that descriptions of the biliary tracts had been made in a variety of species but were widely scattered in the literature. Mann (1924) commented not only upon the incomplete data on the comparative anatomy of the biliary tract, but mentioned that "there are many contradictory statements concerning some of the species which have been dissected and reported. One anatomist records the presence of the gall bladder in a certain species, while another asserts that the species is without a gall bladder."

Interest in the extrahepatic biliary tract has been evidenced since the days of man's earliest experiences in anatomical observation. Thomson (1940) discussed the knowledge of the Babylonians, Assyrians, Greeks and Romans regarding this tract, and referred to observations of Aristotle, Pliny the Elder, and Galen on the presence and absence of the gall bladder.

Cuvier (1805), Wilson (1847), Milne-Edwards (1861), Owen (1866), and Flower (1872) tabulated data concerning the extrahepatic biliary tract. Macalister (1867) reviewed the findings in a large number of species. It is interesting to note that he stated that the gall bladder was absent "in the rat, common mouse, and other species of the genus *Mus*." Rachford (1895) compiled data on the bile and pancreatic ducts in a series of mammals. Huntington (1902) observed the varieties in the arrangement of bile ducts in mammals.

Mann, Brimhall, and Foster (1920) studied twenty species of common domestic and laboratory animals. They were especially interested in the dimensions of the common bile duct in animals with and without a gall bladder. Mann, Foster, and Brimhall (1920) recorded data on the relationship of the common bile duct to the pancreatic duct in fifteen species, and attempted to group the species studied into three main divisions.

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Mentzer (1929a) studied the biliary apparatus in twenty-four species representing five orders of African mammals secured by Pope. He noted the site of entrance of the bile duct into the duodenum, and commented upon the proximity of the entrance to the pylorus in Carnivora, and the farther distance in most Artiodactyla. Gorham and Ivy (1938), from the literature and from dissections, tabulated data on the presence and absence of the gall bladder. Mentzer (1929b) was interested in anomalous bile ducts in man. Operative and autopsy records have indicated many variations in the extrahepatic biliary tract which are significant in surgical procedures. A study of the comparative anatomy of the biliary tract is an aid in the understanding of anomalies which are encountered clinically.

The purpose of this study was to make and record observations on a series of animals to which not only we, but other investigators, may add further data. In several instances only one specimen of a species was available for study. It was felt that the data on these single specimens which are neither readily nor frequently obtainable should be recorded. Other investigators who may dissect only single specimens may find the data of value.

It was first intended only to make a study of the intraduodenal portion of the common bile duct. From various discussions and through a perusal of the literature, it became evident that data on the gross structure of the biliary tract should be recorded.

The animals obtained were studied in as much detail as the amount of material or the condition of the specimen allowed. Some of the material consisted solely of the liver with the attached gall bladder; in a few instances only the duodenum and the dissected ducts were available because the liver had been used by other investigators. In the majority of dissections the entire extrahepatic biliary tract was available for study. The intraduodenal portions of the ducts were prepared and embedded in paraffin preliminary to studies in progress on the microscopical anatomy of this region.

In specimens which possessed a gall bladder, observations were made regarding the common bile duct, formed by the union of the cystic and common hepatic ducts. The common hepatic duct, formed by the union of the right and left hepatic ducts, was particularly observed in specimens in which there was no gall bladder. Unless especially stated, no marked pathology was demonstrable in the specimens. The character of the wall of the gall bladder was determined only by palpation of the structure and by its opacity.

Measurements recorded where two or more specimens were available are average measurements.

MARSUPIALIA

Wallaby (*Macropus* sp.). One specimen.

The gall bladder was piriform in shape and its wall was firm and relatively thick. The common bile duct was 11 cm. in length. The pancreatic duct and the common bile duct coursed together but remained separate structures until they reached a dilatation located outside the duodenal wall at a distance of 6.5 cm. from the pylorus. The opening from the dilatation into the duodenum was located on a small papilla situated in a shallow depression in the duodenal wall.

Tasmanian Devil (*Sarcophilus harrisii*). One specimen.

The gall bladder was elongated in shape and protruded beyond the margin of the liver. For two-thirds of its length it was attached loosely to the liver by a peritoneal fold. The fundus had no attachment to the liver. The bile and pancreatic ducts coursed side by side to their opening on a low duodenal papilla located 2.4 cm. from the pylorus.

Flying Phalanger (*Petaurus norfolcensis*). Two specimens.

The gall bladder was loosely lodged in its fossa and attached to the liver by connective tissue. The bile and pancreatic ducts coursed together and emptied into a large dilatation just outside the duodenal wall, as in the wallaby.

Tree-Kangaroo (*Dendrolagus matschiei*). One specimen.

A gall bladder was present. The ducts coursed together side by side but remained separate until just before their termination. They opened into a common ampulla in the duodenal papilla.

Mexican Opossum (*Didelphis mesamericana*). Four specimens.

On one surface the gall bladder was attached tightly to the liver by connective tissue almost to its tip. The common bile duct and the pancreatic duct coursed together for a distance of 2.3 cm. There was an elongated swelling located outside the duodenal wall. The common bile duct and the pancreatic duct opened into this structure. From it there was a communication with the duodenum by a short duct.

PRIMATES

Chimpanzee (*Pan satyrus*). Two specimens.

The long, cylindrical gall bladder had a firm, thick wall. In the adult specimen which was examined the fundus was bent on itself. There were no peritoneal bands holding it in this position. The gall bladder projected beyond the margin of the liver. The common bile duct and the pancreatic duct coursed together but remained individually distinct. They opened together on a prominent duodenal papilla located 16 cm. from the pylorus.

Orang-utan (*Pongo pygmaeus*). One specimen.

A gall bladder was present. The common bile duct and the pancreatic duct opened separately on a prominent duodenal papilla which was located 9 cm. caudad to the pylorus.

Rhesus Macaque (*Macaca mulatta*). Twelve specimens.

The gall bladder was long and narrow and had a thin wall. Approximately one-third of the viscus was closely related to the hepatic substance. The pancreatic duct coursed with the common bile duct. The two ducts opened on a prominent duodenal papilla located 1.8 cm. from the pylorus. A bristle passed through each of these ducts showed that the ducts either opened separately on the duodenal papilla (three specimens) or joined together in the duodenal papilla (nine specimens).

Marmoset (*Tamarin ursulus*). Two specimens.

The gall bladder was located in a deep fossa. The common bile duct and the pancreatic duct coursed side by side to the duodenum. A duodenal papilla was present.

EDENTATA

Armadillo (*Dasypus novemcinctus*). Three specimens.

The gall bladder was long and narrow and located in a shallow fossa of the liver. The pancreatic and common bile ducts entered the duodenum side by side, and opened separately on a small papilla situated 4.5 cm. caudad to the pylorus.

RODENTIA

African Porcupine (*Hystrix cristata*). Two specimens.

The gall bladder was elongated, did not project beyond the margin of the liver, and had firm walls. The common bile duct entered the

duodenum very near to the pylorus on a prominent papilla separately from the pancreatic duct. The latter opened 5.6 cm. caudad to the pylorus.

Guinea Pig (*Cavia porcellus*). Eight specimens.

The gall bladder had a very thin wall and was suspended loosely from the liver by a thin peritoneal fold. The common bile duct emptied into the duodenum just caudad to the pylorus. The pancreatic duct opened into the hepatic duct.

Brown Rat (*Rattus norvegicus*). Four specimens.

There was no gall bladder. The hepatic duct opened 2.2 cm. from the pylorus. The pancreatic duct opened into the hepatic duct.

House Mouse (*Mus musculus*). Four specimens.

The gall bladder was small and closely adherent to the substance of the liver. Its wall was thin. The common bile duct into which the pancreatic duct emptied, opened into the duodenum 1.6 cm. from the pylorus.

Striped Ground Squirrel (*Citellus tridecemlineatus*). One specimen.

The gall bladder was oval in shape and closely adherent to the liver. The common bile duct opened 6 mm. caudad to the pylorus.

Pocket Gopher (*Geomys bursarius*). One specimen.

There was no gall bladder. The hepatic duct opened 4.6 cm. caudad to the pylorus. The pancreatic duct opened into the hepatic duct.

Rabbit (*Oryctolagus cuniculus*). Four specimens.

The gall bladder was elongated and its wall was thin. The common bile duct entered the duodenum 1 cm. beyond the pylorus. There was a duodenal papilla. The pancreatic duct opened 42 cm. caudad to the opening of the common bile duct.

CARNIVORA

Little Panda (*Ailurus fulgens*). One specimen.

The gall bladder was oval in shape and loosely attached to the hepatic substance by connective tissue. The wall was firm. The pancreatic duct joined with the common bile duct before the latter entered the duodenum.

Binturong (*Arctictis binturong*). One specimen.

There was a deep fossa in the liver for the gall bladder, which was elongated in shape and did not extend beyond the margin of the liver. The pancreatic duct entered the common bile duct 3.6 cm. from the point of entrance of this duct into the duodenum. There was no duodenal papilla.

Black Bear (*Euarctos americanus*). One specimen.

The gall bladder was piriform, had thick walls, and was loosely connected to the substance of the liver by a peritoneal fold. The prominent duodenal papilla was located 11 cm. caudad to the pylorus.

Dog (*Canis familiaris*). Four specimens.

The gall bladder was located in a deep fossa. It was piriform in shape; its wall was firm. The pancreatic duct coursed with the common bile duct, and the two ducts opened separately on a low duodenal papilla located 4.5 cm. from the pylorus.

Cat (*Felis domestica*). Four specimens.

The gall bladder was piriform; its fundus projected beyond the liver's margin. The cystic duct was spiral in shape. The common bile duct opened into the duodenum 2.8 cm. from the pylorus. The pancreatic and common bile ducts coursed side by side to the duodenum. There was a low duodenal papilla.

CETACEA

Finback Whale (*Balaenoptera physalus*). One specimen.

The specimen was a 62-inch foetus. There was no gall bladder. The duodenum was closely attached to the liver. Within the duodenum there was a clearly defined longitudinal ridge, which was 3.4 cm. in length. At its distal extremity there was a small opening. Probing the hepatic duct with a bristle showed it to be continuous with the ridge. The duct opened 4.2 cm. from the pylorus.

HYRACOIDEA

Dassie (*Procavia* sp.). One specimen.

There was no gall bladder. There were two hepatic ducts. The right hepatic duct was 19 mm. in length and into it opened five interlobular ducts. The left hepatic duct was 7 mm. in length and had only two small interlobular ducts. The dilatation in the right hepatic

duct contained several yellow concretions. Four small concretions of irregular shape were found in the common hepatic duct. These calcareous masses in no place completely occluded the right hepatic duct or the common hepatic duct.

The common hepatic and pancreatic ducts opened separately into a shallow depression which was 22 mm. caudad to the pylorus. The margins of this depression were definitely elevated. There was no duodenal papilla. A fuller discussion of this interesting specimen was given by Thomson (1938).

SIRENIA

Florida Manatee (*Trichechus latirostris*). One specimen.

There was a pear-shaped gall bladder which projected beyond the margin of the liver. A short cystic duct united with the common hepatic duct. The common bile duct opened on a prominent papilla located 7 cm. from the pylorus. The pancreatic duct did not open into the duodenum with the bile duct.

PERISSODACTYLA

Zebra (*Equus burchelli*). One specimen.

There was no gall bladder. There was a distinct papilla in the duodenum. The main pancreatic duct entered the duodenum in company with the common hepatic duct. A second pancreatic duct opened near this opening.

Horse (*Equus caballus*). One specimen.

There was no gall bladder. The pancreatic duct and the common hepatic duct entered the duodenum side by side. There was a duodenal papilla. A second pancreatic duct opened 3 cm. caudad to the duodenal papilla.

ARTIODACTYLA

Sheep (*Ovis aries*). Seven specimens.

The gall bladder was located in a definite fossa and projected slightly beyond the margin of the liver. The wall was firm and thick. The pancreatic duct emptied into the common bile duct, which terminated on a duodenal papilla 34 cm. from the pylorus.

White-tailed Deer (*Odocoileus virginianus*). One specimen.

There was no gall bladder. The hepatic duct opened into the duodenum 16 cm. from the pylorus. The pancreatic duct opened into the hepatic duct before the latter entered the duodenum.

Domestic Cow (*Bos taurus*). Seven specimens.

The gall bladder was large in size and piriform in shape. Its wall was firm. It was loosely attached to the liver by connective tissue. Ducts were observed passing into the side of the gall bladder from the substance of the liver. These cysto-hepatic ducts were injected with gelatin, and their course ascertained. The common bile duct opened into the duodenum on a papilla which was located 61 cm. caudad to the pylorus. The pancreatic duct opened separately into the duodenum.

Pig (*Sus scrofa domestica*). Seven specimens.

The gall bladder was oval in shape. The common bile duct entered the duodenum 3.4 cm. beyond the pylorus. The pancreatic duct opened into the duodenum 12.5 cm. caudad to the opening of the common bile duct. The duodenal papilla was large.

DISCUSSION

1. On the presence or absence of the gall bladder.

The presence or absence of a gall bladder in the animals studied is indicated in Table 1. A gall bladder was absent in only seven of thirty-one species of mammals. These were the whale, the zebra, the horse, the dassie, the white-tailed deer, the brown rat, and the pocket gopher.

A gall bladder was present in all specimens of Marsupialia, Primates, Edentata, and Carnivora in this series. A gall bladder was present in three species of Artiodactyla and absent in one. In the one specimen of Sirenia there was a gall bladder. In Hyracoidea, Perissodactyla, and Cetacea there was no gall bladder. In Rodentia, as in Artiodactyla, there was decided variability among the species. There was no gall bladder in the brown rat; it was present in the house mouse. It was absent in the pocket gopher and present in the striped ground squirrel. The explanations for such variations have occasioned much discussion. Higgins (1926) called attention to the relatively similar environmental factors in the rat and mouse. Schmidt and Ivy (1937) and Gorham and Ivy (1938) have recently discussed the problem.

The relationship of the gall bladder to the liver showed extensive variation not only between, but also within, orders. The gall bladder was loosely connected to the liver in the Marsupialia studied, except in the opossum, in which one surface was attached tightly to the

liver. In the Tasmanian devil the gall bladder was loosely attached to the liver by a peritoneal fold for two-thirds of its length; in the flying phalanger it was loosely lodged in the fossa.

In Primates the close attachment of the gall bladder to the liver was particularly marked in the macaque. Among Carnivora the fossae for the organ were especially deep in the binturong and the dog. In the little panda and the black bear the gall bladder was loosely attached to the liver. In Artiodactyla and Rodentia the relationships between the gall bladder and the liver were exceedingly variable.

The wall of the gall bladder showed marked variations. It was firm in Marsupialia and Artiodactyla; thick in Carnivora and the Primates. There was much variability among the Rodentia, e.g., the wall was thin in the guinea pig and the house mouse but was thick in the African porcupine.

2. The relationship of the common bile duct or the common hepatic duct (when there is no gall bladder) with the pancreatic duct.

Mann, Foster, and Brimhall (1920) were interested in the relationship of the common bile duct or the common hepatic duct with the pancreatic duct. They studied this relationship in common domestic and laboratory animals. Table 2 is a tabulation of such data in the animals observed in this study. Three types of relationships may be considered:

Type A: That condition in which the pancreatic duct and the bile duct coursed together to the duodenal wall. The ducts retained their individuality until they reached the duodenum, where they either entered separately, but very close to each other, or entered a common ampulla.

From Table 2 it will be observed that all of the specimens of Marsupialia, all of the Primates, both species of Perissodactyla, and the one species each of Edentata and Hyracoidea are grouped under this type. Two species of Carnivora also belong in this classification. There appears to be no taxonomic correlation with the presence or absence of a gall bladder. The Primates, Marsupialia, one species of Edentata, and two of Carnivora possess the organ, but a gall bladder is missing in Perissodactyla and the one specimen of Hyracoidea.

Type B: That condition in which the pancreatic and common bile ducts entered into the duodenum separately at a variable distance from each other.

This condition was observed in four species of Rodentia, two of Artiodactyla, and one of Sirenia (Table 2). The greatest distance between the openings of the ducts was observed in the rabbit. The entrance of the pancreatic duct was 42 cm. caudad to the entrance of the common bile duct. It should be noted that a gall bladder was present in all of these species.

Type C: That condition in which the pancreatic duct emptied into the bile duct at a variable distance from the opening of the latter into the duodenum. By reference to Table 2, it will be observed that one species of Artiodactyla, two of Carnivora, and two of Rodentia are listed under this type.

There was particular variability among the Rodentia, the order in which the presence or absence of the gall bladder was especially variable. There was no correlation between the type of relationship of the common bile duct and the pancreatic duct and the presence or absence of the gall bladder. The house mouse (*Mus musculus*), which possessed a gall bladder, was in Type C, and the brown rat (*Rattus norvegicus*), which lacked a gall bladder, was also in Type C.

3. The presence of a duodenal papilla.

Table 3 indicates the presence or absence of a duodenal papilla. A study of this table reveals certain facts:

(*a*) The size of the duodenal papilla varied greatly. It was prominent in the black bear, which had a gall bladder, and equally prominent in the zebra, in which there was no gall bladder.

(*b*) The presence of the duodenal papilla was not related to the presence of a gall bladder, e.g., it was not present in the binturong, which had a gall bladder, nor in the dassie, which did not have a gall bladder.

(*c*) The duodenal papilla varied within an order in both its presence and size. It was absent in the binturong and present in the black bear. Both of these animals are species of Carnivora and possessed gall bladders. The duodenal papilla was prominent in the black bear and very small in the dog, yet both of these are species of Carnivora.

(*d*) The duodenal papilla was present in both carnivorous and herbivorous animals, e.g., the bear and the domestic cow.

4. The distance of the opening of the bile duct from the pylorus.

Reference to Table 4 indicates the marked variability in the distance from the pylorus to the opening of the bile duct. It is of

interest to note that the opening was nearest to the pylorus in two species of Rodentia, the African porcupine and the guinea pig, and that both of these species possessed gall bladders. A marked difference was seen in two species of Artiodactyla, which had gall bladders. In the domestic cow the opening was 62 cm. caudad to the pylorus; in the pig it was 3.4 cm. (the length of the small intestine of the cow is approximately three times that of the pig).

5. The relation of these studies to literature on the extrahepatic biliary tract.

Mann's comment (1924) to the effect that statements regarding the comparative anatomy of the extrahepatic biliary tract are often contradictory was borne out in our perusal of the literature and in these investigations. Macalister (1867) reported that there was no gall bladder in the "common mouse and other species of the genus *Mus,*" but in the specimens studied in this series it was present. Mann, Brimhall, and Foster (1920) also reported its presence.

One of the interesting questions which arose concerned the presence or absence of a gall bladder in the dassie. In a review by Thomson (1938) of a series of reports which included descriptions of the extrahepatic biliary tract of the dassie, it was shown that eleven authors reported no gall bladder. Contrary to references in the clinical literature, neither Owen nor Macalister reported the presence of a gall bladder. In the available accounts of dissections of dassies no one has reported the presence of a gall bladder except Mentzer, who based his accounts on descriptions and drawings made by Pope. The dilatation described was undoubtedly just an enlargement of the hepatic duct and not a gall bladder. There was no gall bladder in the specimen of hyrax studied in this series, but the right hepatic duct was enlarged and contained yellow concretions.

SUMMARY

(1) Dissections of the extrahepatic biliary tract of ninety-one specimens representing thirty-one species of Mammalia were made. The gall bladder was absent in seven species.

(2) The shape, character of the wall, and relationship of the gall bladder to the liver showed marked variations.

(3) A study of the relationships of the pancreatic and common bile ducts to each other showed that (*a*) both ducts may enter the duodenum separately (porcupine, manatee, pig); (*b*) ducts may course together to the duodenal wall before uniting (marmoset, wallaby,

dassie, tree-kangaroo); (*c*) the pancreatic duct may empty into the common bile duct at a variable distance from the opening of the latter into the duodenum (binturong, rat, pocket gopher).

(4) The distance of the point of entrance of the ducts from the pylorus, and the presence of the duodenal papilla showed much variability.

(5) The duodenal papilla varied within an order both as to presence and prominence.

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TABLE 1.—THE PRESENCE AND ABSENCE OF THE GALL BLADDER

Order	Species	Gall bladder
Marsupialia	*Macropus* sp.	+
	Sarcophilus harrisii	+
	Petaurus norfolcensis	+
	Dendrolagus matschiei	+
	Didelphis mesamericana	+
Primates	*Pan satyrus*	+
	Pongo pygmaeus	+
	Macaca mulatta	+
	Tamarin ursulus	+
Edentata	*Dasypus novemcinctus*	+
Rodentia	*Hystrix cristata*	+
	Cavia porcellus	+
	Rattus norvegicus	−
	Mus musculus	+
	Citellus tridecemlineatus	+
	Geomys bursarius	−
	Oryctolagus cuniculus	+
Carnivora	*Ailurus fulgens*	+
	Arctictis binturong	+
	Euarctos americanus	+
	Canis familiaris	+
	Felis domestica	+
Cetacea	*Balaenoptera physalus*	−
Hyracoidea	*Procavia* sp.	−
Sirenia	*Trichechus latirostris*	+
Perissodactyla	*Equus burchelli*	−
	Equus caballus	−
Artiodactyla	*Ovis aries*	+
	Odocoileus virginianus	−
	Bos taurus	+
	Sus scrofa domestica	+

TABLE 2.—RELATION OF PANCREATIC AND BILE DUCTS

Key

Type A: Ducts course together to duodenal wall.
Type B: Ducts enter duodenum separately at variable distance from each other.
Type C: Pancreatic duct joins bile duct at distance from opening of the latter into the duodenum.

Species	Type	Gall bladder
Macropus sp.	A	+
Sarcophilus harrisii	A	+
Petaurus norfolcensis	A	+
Dendrolagus matschiei	A	+
Didelphis mesamericana	A	+
Pan satyrus	A	+
Pongo pygmaeus	A	+
Macaca mulatta	A	+
Tamarin ursulus	A	+
Dasypus novemcinctus	A	+
Hystrix cristata	B	+
Cavia porcellus	B	+
Rattus norvegicus	C	−
Mus musculus	C	+
Citellus tridecemlineatus	B	+
Geomys bursarius	C	−
Oryctolagus cuniculus	B	+
Ailurus fulgens	C	+

TABLE 2—*Continued*

Species	Type	Gall bladder
Arctictis binturong	C	+
Canis familiaris	A	+
Felis domestica	A	+
Procavia sp.	A	−
Trichechus latirostris	B	+
Equus burchelli	A	−
Equus caballus	A	−
Ovis aries	C	+
Bos taurus	B	+
Sus scrofa domestica	B	+

TABLE 3.—THE PRESENCE AND ABSENCE OF A DUODENAL PAPILLA

Species	Papilla		Gall bladder
Dendrolagus matschiei	+		+
Macropus sp.	+	(small)	+
Petaurus norfolcensis	+	(small)	+
Sarcophilus harrisii	+	(small)	+
Pan satyrus	+	(prominent)	+
Pongo pygmaeus	+	(prominent)	+
Macaca mulatta	+		+
Tamarin ursulus	+		+
Dasypus novemcinctus	+		+
Hystrix cristata	+		+
Cavia porcellus	+		+
Oryctolagus cuniculus	+		+
Arctictis binturong	−		+
Euarctos americanus	+	(prominent)	+
Canis familiaris	+	(small)	+
Felis domestica	+	(small)	+
Balaenoptera physalus (foetal)	+	(longitudinal fold)	−
Procavia sp.	+		−
Trichechus latirostris	+	(prominent)	+
Equus burchelli	+		−
Equus caballus	+		−

TABLE 4.—THE DISTANCE OF THE OPENING OF THE BILE DUCT FROM THE PYLORUS

Species	Distance in centimeters	Gall bladder
Macropus sp.	6.5	+
Sarcophilus harrisii	2.4	+
Pan satyrus	16.0	+
Pongo pygmaeus	9.0	+
Macaca mulatta	1.8	+
Dasypus novemcinctus	4.5	+
Hystrix cristata	Just distal to pylorus	+
Cavia porcellus	Just distal to pylorus	+
Rattus norvegicus	2.2	−
Mus musculus	1.6	+
Geomys bursarius	4.6	−
Oryctolagus cuniculus	1.0	+
Canis familiaris	4.5	+
Felis domestica	2.8	+
Balaenoptera physalus (foetal)	4.2	−
Procavia sp.	2.2	−
Trichechus latirostris	7.0	+
Ovis aries	34.0	+
Odocoileus virginianus	16.0	−
Bos taurus	61.0	+
Sus scrofa domestica	3.4	+

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NEW AND LITTLE KNOWN NEOTROPICAL HISTERIDAE (COLEOPTERA)

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The Histeridae of the Neotropical region have been little studied, the greater part of the described species being known only from the original descriptions and scattered records. Undescribed forms are to be found in almost any collection of appreciable size, as, for example, the one here dealt with, which includes forty-four species, of which twenty-one are new. The material treated in this paper has been assembled from several sources: (1) A collection made by Dr. Charles H. Seevers and Henry S. Dybas in Colombia in 1938; (2) a few specimens collected by Dr. Seevers in Mexico during the summer of 1936; (3) one specimen from the collection of the United States National Museum; (4) a small series collected by Dr. Eliot C. Williams at Barro Colorado Island, Panama Canal Zone, during the summer of 1938; and (5) specimens collected by Karl P. Schmidt on the Leon Mandel–Field Museum Expedition to Guatemala in 1933–34. Certain genera probably containing more than 50 per cent of undescribed species have been almost entirely disregarded in this study, because inadequate descriptions make proper assignment of names impossible at this time.

Acknowledgment is due the individuals and the officials of the institutions mentioned above for their kind co-operation in making material available for study.

Since little has been published on the terminology employed in the descriptions of Histeridae, illustrations (pl. XIII; pl. XIV, fig. 1) are included to clarify the names applied by the writers to the striae commonly found in many of the Histeridae. It is to be remembered that many of the species do not conform at all closely in striation to the type illustrated, but may possess a complement of striae which is the result of a varying extent of loss and reduction or, in some cases, of duplication and addition. In many genera the homologies of certain striae are difficult to determine, particularly when considerable reduction has taken place. The figures are not to be construed as a reconstruction of a primitive generalized type of striation.

All measurements of total length were made from the anterior angles of the pronotum to the tip of the pygidium; width was measured at the broadest part of the body, this nearly always being

at, or behind, the humeri. For proportions of length to width of the pronotum, the measurements of length were made along the median line; of width, across the posterior angles.

Subfamily **Hololeptinae**

Eutidium oblitum Marseul

Phylloma oblitum Marseul, Ann. Soc. Ent. France, (3), 1, p. 194, pl. 5, fig. 2, 1853—Colombia (Carthagena).

Colombia: Villavicencio, Meta Intendencia, one specimen from under bark, July 11, 1938 (Dybas).

Hololepta (Hololepta) bidentata Marseul

Hololepta bidentata Marseul, Ann. Soc. Ent. France, (3), 1, p. 156, pl. 4, fig. 14, 1853—Venezuela (Caracas).

Colombia: Villavicencio, four males, three females, from under bark, July 25, 1938 (Dybas).

In describing this species, Marseul stated that the males do not have the anterior angles of the pronotum emarginate. Only one of the males of our series agrees with this description; the other three have these angles slightly but distinctly emarginate, as in *H. colombiana* Marseul.

Hololepta (Hololepta) bogotana Marseul

Hololepta bogotana Marseul, Ann. Soc. Ent. France, (3), 1, p. 184, pl. 4, fig. 26, 1853—Guatemala (Lake Izabal) and Venezuela (Caracas).

Colombia: Villavicencio, one female, two males, July 11, 1938 (Dybas).

Hololepta (Leionota) devia Marseul

Leionota devia Marseul, Ann. Soc. Ent. France, (3), 1, p. 211, pl. 5, fig. 9, 1853—Brazil and French Guiana (Cayenne).

Colombia: Villavicencio, one male, July 25, 1938 (Dybas).

The specimen at hand answers well to the description of this species but does not have the sides of the pronotum nearly so angulate as figured by Marseul. Since Marseul's figures are often exaggerated, there is little doubt as to the identity of the specimen.

Hololepta (Leionota) cobanensis sp. nov.

Type from Coban, Guatemala. In the collection of Field Museum of Natural History. Female. Collected March 22, 1934, by Karl P. Schmidt.

Description.—Form oblong-subparallel, feebly convex. Color black, shining. Mandibles without teeth. Head sparsely punctulate;

frontal stria consisting of two disconnected transverse strioles, longitudinal interocular stria short, well impressed; transverse supra-orbital stria not visible; preocular tooth well developed.

Pronotal width double the median length, sides feebly arcuate on basal two-thirds, strongly arcuate and convergent on apical third; basal margin bisinuate. Marginal pronotal stria present on each lateral fifth along the basal margin, complete along the sides, deeply impressed around the anterior angles and interrupted on each side behind the eyes, a median detached portion being present along the middle. Sides with a few moderate punctures near the margin; disk sparsely, very finely punctulate.

Elytra together about two-thirds broader than long and nearly two-thirds longer than the pronotum. Epipleura smooth. Sub-humeral stria present from near base to apical fifth, very coarse and sulciform at middle. First dorsal stria well impressed, present on basal third; second dorsal stria a little more than half the length of the first and with an appendix which extends from apical fifth to near the margin.

Propygidium sparsely, moderately coarsely punctate on each side, apex feebly bifoveolate. Pygidium rather coarsely, densely, umbilicately punctate on basal four-fifths, apical fifth sparsely punctulate. A coarse, sulciform marginal stria is present on each lateral fifth of the basal margin and extends nearly to apex along the lateral margins.

Prosternum sparsely punctulate, constricted at middle, the median width less than half the basal. Prosternal lobe somewhat produced, longest at middle. Mesosternum with a marginal stria on each side around the anterior angles.

Anterior tibiae four-dentate, the two apical teeth being the largest and approximate, the basal tooth smallest. Middle tibiae four-dentate, the teeth evenly spaced, the basal tooth minute. Posterior tibiae with three teeth on the superior ridge; inferior ridge non-dentate.

Measurements.—Length 6.7, width 4.02 mm.

Remarks.—The pygidial characters and elytral striation seem to indicate that this species is most closely allied to *H.* (*Leionota*) *confusa* Marseul, but it may be distinguished from that species by its less coarsely punctate propygidium, the presence of a short interocular stria on each side of the head, its transversely bistriate front, and its much smaller size. The character of the marginal pronotal stria along the apical margin seems to be unique in this subgenus.

Hololepta (Leionota) confusa Marseul

Leionota confusa Marseul, Ann. Soc. Ent. France, (3), 1, p. 205, pl. 5, fig. 3, 1853—Mexico.

Guatemala: Coban, a male, March 22, 1934 (Schmidt); Volcan Tajamulco, a female found in bromeliads at seven to nine thousand feet elevation, March 16, 1934 (Schmidt).

The female is doubtfully associated with the male. Both specimens differ from Marseul's description and figure in that they have the pygidium margined as in the preceding new species rather than completely margined apically; possibly they may represent a new species.

Subfamily Trypanaeinae

Coptotrophis proboscideus Fabricius

Bostrichus proboscideus Fabricius, Syst. Eleuth., 2, p. 385, 1801.

Trypanaeus proboscideus Marseul, Ann. Soc. Ent. France, (3), 4, p. 128, pl. 2, figs. 21, 21g, 1856.

Trypanaeus carthagenus Marseul, Ann. Soc. Ent. France, (3), 5, p. 402, pl. 11, fig. 21, 1857 (male).

Colombia: Villavicencio, one male and one female from scolytid beetle burrows, July 25, 1938 (Dybas).

Subfamily Abraeinae

Bacanius hamatus Lewis

Bacanius hamatus Lewis, Biol. Centr.-Amer., Coleop., 2, pt. 1, p. 237, pl. 7, fig. 12, 1888—Guatemala (San Geronimo).

Panama Canal Zone: Barro Colorado Island, one specimen from leaf mold, July 9, 1939 (Williams).

Bacanius scalptus Lewis

Bacanius scalptus Lewis, Biol. Centr.-Amer., Coleop., 2, pt. 1, p. 237, pl. 7, fig. 10, 1888—Guatemala (El Tumbador, Zapote, El Reposo) and Cuba.

Colombia: Villavicencio, six specimens, July 11, 1938 (Seevers and Dybas); Puerto Berrio, Antioquia, thirteen specimens, August 16, 1938 (Dybas); Puerto Salgar, Cundinamarca, nine specimens, July 31, 1938 (Dybas).

Mexico: Cordoba, Vera Cruz, two specimens, July 26, 1936 (Seevers).

This species has also been collected in Brazil.

Bacanius subcarinatus sp. nov.

Type from Cordoba, Vera Cruz, Mexico. In the collection of Field Museum of Natural History. Sex undetermined. Collected July 20, 1936, by Charles H. Seevers.

Paratypes.—Two specimens, same locality and date as the type, one in the collection of Rupert L. Wenzel, one in the collection of Edward S. Ross.

Description.—Form oval, strongly convex. Color varying from rather pale testaceous to reddish brown, shining. Head without striae; vertex sparsely, microscopically punctate; epistoma with fine, strong, sparse, setigerous punctures, hairs very short, inconspicuous.

Pronotum nearly twice as broad as long, sides straight, strongly convergent, basal margin broadly, evenly arcuate. Marginal stria complete, strongly impressed. Disk with moderate, strong, sparse punctures, these becoming microscopic laterally. Submarginal antescutellar row of punctures not present.

Scutellum not visible. Elytra together nearly as long as broad, sides strongly arcuate and (behind the middle) strongly convergent to suture; very sparsely, microscopically punctulate throughout, the punctures considerably stronger and coarser along the suture on basal half. Epipleura with a fine subcariniform stria. Marginal stria fine, subcariniform, extending from base to apex, close to the epipleural stria. First dorsal stria complete, fine, subcariniform, extending from base around apical angle to suture.

Pygidium with a few microscopic punctures.

Prosternal keel broad, about as long as broad, sides straight; the lateral marginal prosternal striae join the marginal stria of the prosternal lobe on each side; carinal striae not well impressed, straight, extending a little beyond the middle. Prosternal lobe very short, microscopically punctulate. Mesosternum with anterior margin rather broadly subsinuate, nearly truncate at middle, the margin oblique each side of the truncated portion; marginal mesosternal stria broadly interrupted at middle; disk with a few shallow punctures. Meso-metasternal stria absent (suture visible as a dark line). Metasternum sparsely, shallowly, coarsely punctate, a small area at middle sometimes nearly smooth; lateral metasternal stria absent.

Anterior tibiae expanded, outer margin strongly arcuate on basal third, straight and nearly parallel to the inner margin on middle third, with a very distinct short tooth one-third from apex, the margin obliquely convergent thence to apex; the outer margin has a number of extremely short spinules on basal two-thirds which are visible only under very high magnification. Tarsi of all the legs with five tarsomeres.

Measurements.—Length 0.8–0.95, width 0.6–0.7 mm.

Remarks.—This species is apparently most closely allied to *B. humicola* Marseul and *B. ferrugineus* Bickhardt, but differs from the former in its punctation and in the possession of a complete dorsal stria in addition to the marginal elytral stria; from *B. ferrugineus*, *subcarinatus* differs in its rather coarsely, shallowly, sparsely punctate metasternum.

The following provisional key may be of aid in identifying the known neotropical *Bacanius:*

1. Form broadly oval (as in *Anapleus*), strongly convex; a well-defined, crenate, hamiform sutural stria present, this extending from basal fourth to a little beyond the middle, thence abruptly angulate and arcuately, outwardly recurving to middle.................. *B. hamatus* Lewis; Guatemala, Panama.

1a. Form more narrowly oval, strongly convex, sutural stria absent...........2

2. Elytra coarsely, closely, deeply punctate, the punctures connected by grooves; first dorsal stria arching across the elytral base and recurving at about one-third from suture................. *B. scalptus* Lewis; Mexico to Brazil, Cuba.

2a. Elytra for the most part minutely punctate, the punctures sparse and never connected by short grooves; first dorsal stria, when present, not arching across the elytral base...3

3. Metasternum smooth, impunctate (or at most remotely punctulate)........4

3a. Metasternum rather coarsely, sparsely, shallowly punctate; elytral punctures coarsest on basal half along the suture...... *B. subcarinatus* sp. nov.; Mexico.

4. Elytra very finely, sparsely punctate, the punctures noticeably more distinct near apex, dorsal elytral stria abbreviated at basal third; prosternal lobe minutely, rugulosely punctate..... *B. convergens* Schmidt (1896, p. 65); Brazil.

4a. Elytra very finely, sparsely, rather uniformly punctate, "subhumeral stria" complete; prosternal lobe with a few scattered, minute punctures.
B. ferrugineus Bickhardt (1918, p. 286); Guadeloupe.

4b. Surface smooth, impunctate. .*B. humicola* Marseul (1856, p. 570); Venezuela.

The terminology of the striae demands explanation. The writers have followed Schmidt in referring to the innermost stria of the elytral flank as the first dorsal stria; it is this stria which arches across the elytral base in *B. punctiformis* and *B. scalptus* and which has been called the sublateral stria by Casey; by Marseul, it has apparently been at times referred to as the marginal and at times as the subhumeral, although a "true" subhumeral stria has not been seen in any species examined and possibly the marginal stria has been referred to by that term in some descriptions. Examination of types is necessary to separate more definitely the last three species of the key.

Acritus exiguus Erichson

Abraeus exiguus Erichson, Jahrb. Ins., **1**, p. 208, 1834.

Acritus exiguus Marseul, Ann. Soc. Ent. France, (3), **4**, p. 603, pl. 23, fig. 3, 1856.

Mexico: Cordoba, Vera Cruz, four specimens, July 20, 1936 (Seevers).

The writers know of no other record of this species from the Neotropical region.

Acritus tuberculatus sp. nov.

Type from Villavicencio, Colombia. In the collection of Field Museum of Natural History. Male. Collected July 11, 1938, by Henry S. Dybas.

Allotype.—Same data as the type. A female in the collection of Rupert L. Wenzel.

Paratypes.—Fifty-seven specimens, same data as the type and allotype. Four each are to be deposited in the collections of Field Museum of Natural History, Mr. Edward S. Ross, and Mr. Henry S. Dybas; two each are to be deposited in the collections of the British Museum (Natural History), the United States National Museum, the American Museum of Natural History, the Museum of Comparative Zoology, the California Academy of Sciences, and the Carnegie Museum; the remainder are in the collection of Rupert L. Wenzel.

Description.—Form broadly oval, subdepressed. Color black with a tinge of brown, strongly shining. Head strongly, finely, sparsely punctate, without striae.

Pronotum twice as broad as long, sides nearly straight and feebly convergent on basal two-thirds, more strongly convergent and arcuate on apical third; basal margin broadly bisinuate and moderately coarsely, crenately punctate. Marginal pronotal stria well impressed, complete laterally and around the anterior angles, interrupted behind the head for a distance of about half the width of the head. Surface strongly (not deeply) punctate throughout, the punctures separated by two to four times their diameters and becoming finer laterally and at apex. A submarginal antescutellar row of punctures is not present.

Elytra together a little broader than long (6.6:5.3), nearly twice as long as, and at humeri distinctly broader than, the pronotum; sides evenly arcuate on basal half, arcuate and convergent on apical half. Epipleura smooth, without striae. Marginal elytral stria rather deeply impressed, punctate, extending from base to apex. Dorsal striae represented laterally near base by one to three vague, oblique impressions. Flanks sparsely punctulate; disks more coarsely punctate than pronotal disk, the punctures oval, nearly the same size as those along the posterior pronotal margin, and separated by about one to two times their diameter; along the suture the punctures are more elongate and at middle longitudinally confluent.

Propygidium rather coarsely, sparsely punctate. Pygidium similarly punctate on basal half, the punctures a little finer on apical half.

Prosternum moderately broad, a little more than twice as long as broad, basal width equal to the apical, width at middle three-fourths that of the base, sides evenly arcuate; carinal striae arcuate, diverging basally and apically and united anteriorly on each side with the apical marginal stria; prosternal keel with a few strong, moderate punctures and possessing a small tubercle near the middle. Mesosternum with the anterior margin broadly, feebly sinuate, marginal stria broadly interrupted at middle, sides with a very few rather coarse punctures. Meso-metasternal stria rather coarsely, crenately punctate, and feebly arcuate, often narrowly interrupted on each side and not joined with the marginal stria. Metasternum with a narrow median area nearly smooth, punctate laterally, the punctures becoming very coarse, subaciculate and subconfluent, but abruptly changing on the elevated sides to round, coarse, and sparse.

All the tibiae narrow, slightly widened apically (not dilated), finely spinulose. Tarsi of anterior and middle legs with five tarsomeres, those of the posterior legs with four; ultimate tarsomeres bearing two claws.

Measurements.—Length 0.9–1.0, width 0.6–0.7 mm.

Remarks.—This species is related to *Acritus exiguus* Erichson but may be separated from that species by its more broadly oval form and the minute but distinct tubercle on the prosternal keel.

Acritus punctisternus sp. nov.

Type from Villavicencio, Colombia. In the collection of Rupert L. Wenzel. Sex undetermined. Collected July 11, 1938, by Charles H. Seevers.

Description.—Form oval, strongly convex. Color reddish brown, rather strongly shining. Head without striae; front and epistoma finely, very sparsely punctate, the punctures strong and on the epistoma setigerous, the hairs being short and inconspicuous.

Pronotum nearly twice as broad as long, sides nearly straight and not very strongly convergent on basal two-thirds, a little more distinctly arcuate on apical third; basal margin broadly bisinuate. Marginal pronotal stria complete, well impressed. Surface sparsely, finely, strongly, deeply punctate at middle, the punctures becoming minute laterally. Submarginal antescutellar line composed of punctures (these about twice the size of the discal punctures), arcuate on middle third and about one-sixth removed from basal margin, nearly approximate to the margin on each lateral third of its extent.

Elytra together nearly as long as broad (6.25:6.75), about as long as pronotum is broad, sides arcuate on basal fourth, thence straight nearly to apex. Marginal stria subcariniform, moderately punctate, extending from base to apex. Flanks sparsely punctulate, upper surface very finely, sparsely punctate, the punctures simple baso-laterad but becoming aciculate baso-mesiad and apically, the punctures a little more closely placed and more distinctly aciculate apically along the suture. A short, feebly impressed, rudimentary discal stria is present on lateral third near the middle.

Propygidium finely alutaceous, finely, very sparsely punctate. Pygidium sparsely, minutely punctulate.

Prosternal keel moderately broad, one-half longer than wide, sides feebly arcuate, base feebly emarginate; carinal striae well impressed, transversely united along basal margin, nearly parallel on basal half, slightly divergent apically and united with the deeply impressed transverse apical marginal stria of the prosternum; disk of keel with a few very fine scattered punctures.

Anterior mesosternal margin outwardly, obtusely angulate, the median portion fitting into the feeble emargination of the prosternum. Marginal mesosternal stria feebly arcuate, complete, subcariniform, well impressed. Mesosternal disk sparsely, deeply, coarsely punctate, slightly tumid, and set off from the metasternum and the rest of the mesosternum. Meso-metasternal stria straight, rather coarsely crenate. Metasternal disk feebly, minutely punctulate, the sides with a few coarser, scattered punctures. Anterior tibiae narrow, about twice as wide near apex as at base (not dilated), all the tibiae finely spinulose. Tarsi of the anterior and middle legs with five tarsomeres, those of the posterior legs with four tarsomeres.

Measurements.—Length 0.95, width 0.7 mm.

Remarks.—From other *Acritus* (*sensu stricto*), which have a submarginal row of pronotal punctures and an outwardly, obtusely angulate anterior mesosternal margin, this species may be particularly distinguished by the rather coarsely punctate and tumid mesosternum.

Acritus ignobilis Lewis

Bacanius ignobilis Lewis, Biol. Centr.-Amer. Coleop., 2, pt. 1, p. 238, pl. 7, fig. 2, 1888—Panama (Volcan de Chiriqui).

Colombia: Puerto Berrio, two specimens collected in cow dung, July 5, 1938; Puerto Salgar, two specimens taken in a débris pile outside a nest of *Atta* sp., July 31, 1938 (Dybas).

Acritus (Aeletes) simpliculus Marseul

Acritus simpliculus Marseul, Ann. Soc. Ent. France, (3), 4, p. 616, pl. 14, fig. 15, 1856—Venezuela (Caracas).

Colombia: Villavicencio, four examples from under bark, July 25, 1938 (Dybas).

This species has heretofore been included in *Acritus* (*sensu stricto*), presumably because Marseul described the scutellum as "*a peine distinct,*" though it is not at all visible in our specimens; the scutellum was similarly described by Marseul for *Acritus atomarius* Aubé, which is recognized as an *Aeletes*. The marginal mesosternal stria, described as interrupted in front, is complete in one specimen and continued by punctures in another. Under very high magnification the elytral punctures are seen to be feebly aciculate rather than simple. The pygidium has a distinct punctiform marginal stria, laterally and apically.

Acritus (Aeletes) rugulosus Marseul

Acritus rugulosus Marseul, Ann. Soc. Ent. France, (3), 4, p. 617, pl. 14, fig. 16, 1856—Venezuela (Caracas).

Colombia: Puerto Salgar, six specimens, July 11, 1938; Villavicencio, one example from under bark, July 31, 1938 (Dybas).

This species has formerly also been included in *Acritus* (*sensu stricto*) but belongs in the subgenus *Aeletes*. The elytral punctures on the disks are distinctly aciculate. The pygidium has a very fine marginal stria, laterally and apically.

Subfamily **Dendrophilinae**

Carcinops carinata sp. nov.

Type from Puerto Salgar, Colombia. In the collection of Rupert L. Wenzel. Sex undetermined. Collected July 31, 1938, from a rubbish heap outside a nest of leaf-cutting ants (*Atta* sp.) by Henry S. Dybas.

Description.—Form oblong-oval, moderately convex. Color deep brown; surface densely, minutely alutaceous and subopaque throughout, excepting a rather broad median pronotal area which is smooth and rather strongly shining. Head sparsely punctulate, supraorbital stria present, finely cariniform, continued anteriorly on each side a little beyond the eyes.

Pronotum nearly twice as broad as long, sides nearly straight and feebly convergent on basal two-thirds, strongly arcuate and convergent apically. Marginal pronotal stria finely cariniform, except behind the head, complete. Disk sparsely punctulate on each side.

Elytra together about as broad as long, sides feebly arcuate from base to apex. Marginal epipleural stria finely subcariniform, complete, marginal elytral stria finely cariniform, complete, bent at middle. External subhumeral stria punctate, its outer edge finely carinate, extending from basal sixth to apical third; internal subhumeral stria with the outer edge strongly carinate, extending from base to apical fourth. Dorsal striae one to five complete, their outer edges strongly carinate, the fifth arching at base; sutural stria extending a little beyond the middle. Pygidia very sparsely punctulate.

Prosternal keel slightly narrowed at middle, the carinal striae finely cariniform. Mesosternum with the anterior margin shallowly emarginate, the marginal stria subcariniform, complete, joined on each side with the coarse, strongly cariniform, lateral metasternal stria. Meso-metasternal suture impressed.

Outer margin of anterior tibiae strongly arcuate on basal half, finely serrulate, with a tooth at middle and another near apex, the interval between the teeth emarginate. Outer edge of middle and posterior tibiae with a marginal row of three moderately coarse spinules and several very fine spinules, and a submarginal row of very fine spinules.

Measurements.—Length 1.83, width 1.22 mm.

Remarks.—*C. carinata* can be distinguished from all other described species of the genus by the character of its elytral striae, the outer margins of which are strongly carinate.

Carcinops biinterrupta sp. nov. (pl. XIV, fig. 2)

Type from Villavicencio, Colombia. In the collection of Field Museum of Natural History. Male. Collected from under rotten bark, July 25, 1938, by Henry S. Dybas.

Allotype.—Same data as the type. A female in the collection of Rupert L. Wenzel.

Paratypes.—Nineteen specimens, same data as the type; five specimens, same locality as the type, July 11, 1938; two each in the collections of Field Museum of Natural History, Edward S. Ross, and Henry S. Dybas.

Description.—Form oblong-subparallel, rather strongly depressed, upper surface feebly convex. Color black, shining. Stria of head very fine, feeble, sometimes interrupted in front; front very finely, sparsely punctulate with somewhat coarser fine punctures intermingled.

Pronotum a little more than twice as broad as long, sides nearly straight basally, rather strongly convergent on apical third. Marginal stria complete, well impressed. Basal margin deeply crenate. Antescutellar puncture round, coarse, deeply impressed. Surface distinctly, not densely, punctulate throughout, with sparse, coarser punctures intermingled in a rather broad area on each side.

Elytra together about as broad as long, at humeri slightly broader than pronotum; sides feebly arcuate at base and apex, nearly straight at middle. Marginal epipleural stria complete, finely subcariniform. Marginal elytral stria complete, well impressed. External subhumeral usually absent, often represented by a few disconnected punctures near middle; internal subhumeral represented by a short, coarse impression at base and by a well-impressed finely punctate stria on middle third. Dorsal striae crenately punctate; one to four complete, one to three coarsely impressed at base; fifth dorsal stria extending to basal fourth or third, sutural stria extending a little beyond the middle. Surface punctulate, with a few coarser punctures intermingled near the apical ends of the striae.

Propygidium and pygidium punctulate, with sparse, coarser punctures intermingled.

Prosternum finely, sparsely punctate, between the coxae about one-eighth as wide as the pronotum, the striae well impressed, slightly sinuate at middle and usually transversely joined at base; prosternal lobe as long as the prosternum, very finely, sparsely punctate, without a marginal stria. Anterior margin of mesosternum broadly, feebly emarginate, disk sparsely, indistinctly punctulate; marginal stria deeply impressed, interrupted on each side at the anterior angle, the median detached portion finely subcariniform, its ends distinctly recurving posteriorly. Inner lateral metasternal stria coarsely subcariniform, continuous with the marginal mesosternal stria and extending to the posterior coxae. Outer lateral metasternal stria joined at base to the inner, bowed outwardly and approaching it again at apex. First abdominal sternum within the coxae with a stria on each side extending from basal to apical margin and another just lateral to it which extends from each coxa to apical margin.

Outer margin of anterior tibiae with two teeth, one near middle, the other near apex, the interval between them arcuately emarginate; basally the outer margin is finely serrulate. Outer margin of middle tibiae with two rather stout spinules, one at middle, the other subapical. Posterior tibiae with a subapical tooth.

Measurements.—Length 1.62–2.00, width 0.95–1.1 mm.

Remarks.—*C. biinterrupta* may be distinguished from its near ally, *C. tantilla* Marseul, by its unusual marginal mesosternal stria, its usually smaller and narrower form, and by the presence of two sizes of punctures on the front of the head (evenly punctulate in *tantilla*); only the first of these characters is adequate for the separation of the two species without comparative material.

Carcinops tantilla Marseul

Carcinops tantillus Marseul, Ann. Soc. Ent. France, (3), 3, p. 93, pl. 8, fig. 6, 1855—Venezuela (Caracas).

Colombia: Villavicencio, one hundred specimens, July 11, 1938, and seven specimens, July 25, 1938; Puerto Berrio, six specimens, August 16, 1938 (Dybas).

The internal subhumeral stria of this species is usually abbreviated at about apical fifth or sixth and broadly interrupted basally, though the apical portion may be connected by a row of punctures to the short, coarse, basal portion. A very short dash lateral to the internal subhumeral and just apical to the middle is often present (external subhumeral).

Carcinops misella Marseul

Carcinops misellus Marseul, Ann. Soc. Ent. France, (3), 3, p. 95, pl. 8, fig. 8, 1855—Guatemala.

Colombia: Puerto Salgar, five examples, July 31, 1938; Puerto Berrio, six specimens, August 16, 1938; Villavicencio, fourteen specimens, July 11, 1938 (Seevers and Dybas); three specimens, July 25, 1938 (Dybas).

Carcinops miserula Marseul

Carcinops miserulus Marseul, Ann. Soc. Ent. France, (3), 3, p. 14, 1862; idem, pl. 9, fig. 15, 1861—Colombia.

Colombia: Puerto Salgar, one specimen, July 31, 1938 (Dybas).

The last two species are separated chiefly on the basis of form, *C. misella* having the sides of the elytra distinctly arcuate and the elytra together distinctly broader than the pronotum, while *C. miserula* is of a more narrow form, the elytra together being hardly noticeably broader than the pronotum, and with the sides nearly straight. In addition, *C. misella*, with rare exceptions, has a very short external subhumeral stria near the middle of the elytra just lateral to the inner subhumeral; *C. miserula*, at most, occasionally has a few disconnected punctures representing an external subhumeral.

Subfamily **Histerinae**

Tribe **Tribalini**

Epierus schmidti sp. nov.

Type from Playitas, Izabal, Guatemala. In the collection of Field Museum of Natural History. Male. Collected December 20, 1933, by Karl P. Schmidt.

Allotype.—Same data as the type. A female in the collection of Field Museum of Natural History.

Paratypes.—From Volcan Tajamulco, Guatemala; one female in the collection of Field Museum of Natural History, collected February 18, 1934, by Karl P. Schmidt. From Barro Colorado Island, Panama Canal Zone; one male and one female in the collections of Rupert L. Wenzel and Edward S. Ross, respectively, collected from leaf mold, July 25, 1938, by Eliot C. Williams.

Description.—Form oval, rather strongly convex; color dark reddish brown to brownish black, surface strongly shining, smooth or sparsely punctulate throughout. Supraorbital stria of head fine, complete; frontal stria absent; front very shallowly impressed; anterior margin of clypeus at middle with a small, setigerous tubercle in the male. Labrum with four setae.

Pronotum twice as broad as long, sides nearly straight and convergent on basal half, arcuate and more strongly convergent on apical half. Marginal pronotal stria complete, very finely punctate. Disk smooth or microscopically, sparsely punctulate, with a narrow area of sparse, fine punctures on each side. Anterior to the scutellum a hastiform impression extends from the basal margin nearly to the middle of the disk; the apex of the impression is not very distinct.

Elytra together very slightly broader than long, one-fifth broader than pronotum, sides evenly arcuate, apices sharply truncate, surface microscopically, sparsely punctulate. Epipleura with scattered moderate punctures. Marginal epipleural and marginal elytral striae complete, finely subcariniform; external subhumeral stria absent; inner subhumeral sometimes present on basal fifth. Oblique humeral stria very finely impressed. Dorsal striae one to three complete, not very distinctly punctate; fourth dorsal stria variable, usually nearly complete, abbreviated at basal fourth in one paratype; fifth dorsal stria varying from present on apical fifth to present on apical half; sutural stria abbreviated on basal fourth.

Propygidium deeply, sparsely, moderately punctate. Pygidium with a semicircular sulcus which is marginal along the sides but

about one-fifth removed from the apical margin, thus dividing the pygidium into two parts, of which the small apical portion is smooth, the larger basal portion sparsely, rather coarsely, deeply punctate, excepting a somewhat swollen, smooth area at middle which is much more distinctly gibbous in the female; pygidial punctures coarsest and sometimes confluent laterally.

Prosternal keel rather narrow, twice as wide at base as at middle; carinal striae fine, strongly divergent on basal two-fifths, subparallel apically and extending to the prosternal lobe, the latter with an uninterrupted apical marginal stria. Mesosternum with the anterior margin feebly bisinuate, the marginal stria very fine, complete at middle, not extending posteriorly to the meso-metasternal stria, which is deep, coarsely subcariniform, strongly arcuate, and continuous with the lateral metasternal stria. Metasternum with a few moderate, sparse punctures on the elevated sides. Meso- and metapleurites with coarse, sparse punctures, these sometimes confluent.

Anterior tibiae with the outer edge evenly arcuate, finely multispinulose. Middle and posterior tibiae biseriately spinulose, the spinules of the posterior tibiae being very fine, short, and sparsely placed.

Measurements.—Length 1.8–2.0, width 1.3–1.45 mm.

Remarks.—*E. schmidti* is allied to *E. hastatus* Marseul by virtue of its hastiform pronotal impression, but differs from that species in possessing a sulcate pygidium and less densely punctate pygidia.

Epierus brasiliense Tarsia in Curia (=**Plagiogramma**)

Plagiogramma brasiliense Tarsia in Curia, Ann. Mus. Zool. Univ. Napoli, n.s., 6, No. 15, p. 1, 1935.

Plagiogramma brasiliense is without doubt an *Epierus* of the group to which *E. schmidti* belongs, but is more closely allied to *E. coproides* Marseul and *E. epulo* Marseul, and may possibly be identical with the latter. Tarsia in Curia placed *Plagiogramma* in the subfamily Saprininae but his own figure clearly shows the well-developed broad prosternal lobe characteristic of the Tribalini.

Tribe **Histerini**

The following new genus, *Phelisteroides,* is erected to include *Pseudister pygidialis* Lewis, *P. propygidialis* Hinton, and three new species. All of these are closely related and possess in common a very distinct, rather deep, marginal pygidial sulcus and a rather unusual prosternal structure, the prosternal keel being narrowly

triangular with the striae convergent, straight, and united anteriorly in a narrow, rounded arch. *Phelisteroides* must tentatively be placed in the tribe Histerini because of its emarginate anterior mesosternal margin, despite the fact that study of the genitalia shows the species to be more closely related to *Phelister.*

Phelisteroides gen. nov.

Type *Phelisteroides fungicolus* sp. nov.

Description.—Form oblong-oval, moderately convex, elytra somewhat depressed along the suture. Head with frontal and supraorbital striae; front shallowly impressed. Antennae with eleven articles, inserted under the margin of the front anterior to the eyes; scape moderately stout, not expanded apically; article two cylindrical, articulated with the distal end of the scape; articles three to eight of the funicle very gradually incrassate; antennal club oval, apparently consisting of three articles which are covered with short pubescence and sparser, longer hairs. Labrum transverse, about twice as broad as long, its anterior margin nearly straight.

Pronotum about twice as broad as long, its anterior margin broadly emarginate. Marginal stria and a single lateral pronotal stria present. Elytra striate. Propygidium transverse, about twice as broad as long, coarsely punctate in all the known forms. Pygidium triangular, densely punctulate with coarser punctures intermingled, and possessing a rather deep marginal sulcus laterally and apically.

Prosternum moderately broad, the keel flat, narrowly triangular, margined by striae which converge and unite in a narrow arch anteriorly and which are usually transversely united at base. Prosternal lobe margined. Mesosternum broadly, shallowly, evenly emarginate anteriorly. Marginal mesosternal stria present, not united with the meso-metasternal stria; the latter stria arcuate and approaching the median portion of the marginal mesosternal stria. First abdominal sternum bistriate on each side medial to the coxae. Femora elongate, not very stout, their sides subparallel.

Anterior tibiae with the inner edge nearly straight, fimbriate, the outer margin strongly arcuate and seven–nine denticulate; tarsal grooves straight, only the inner margins well defined. Middle and posterior tibiae as in *Phelister,* tarsal grooves absent.

Phelisteroides miladae sp. nov. (pl. XIV, fig. 5)

Type from Villavicencio, Colombia. In the collection of Rupert L. Wenzel. Female. Collected July 25, 1938, from under rotten bark, by Henry S. Dybas.

Paratype.—Same data as the type. A female in the collection of Edward S. Ross.

Description.—Form feebly oblong-oval, convex, elytra distinctly depressed along the suture. Color black, shining; legs, mouth parts, and antennae reddish brown. Head with a complete, semicircular, supraorbital stria; frontal stria not joined with supraorbital, slightly interrupted on each side, uninterrupted and inwardly angulate at middle. Front moderately strongly impressed, sparsely punctulate.

Pronotum about twice as broad as long, sides feebly arcuate and nearly parallel on basal half, thence strongly arcuate and convergent to apical angles; anterior margin broadly emarginate, the median portion of the emargination straight, not arcuate; basal margin broadly arcuate. Marginal stria fine, complete. Lateral pronotal stria complete, crenately punctate, strongly recurving around the anterior angles and acutely angulate on each side behind the eyes, the median transverse portion behind the head (between the angulations) very feebly outwardly arcuate. Disk sparsely punctulate throughout, each lateral fifth with rather coarse, elongate punctures.

Elytra together slightly broader than pronotum; surface sparsely punctulate. Marginal elytral stria deep, punctate, extending from base to apex. External subhumeral stria very coarse, subsulciform, slightly abbreviated at basal sixth; internal subhumeral stria represented by a row of poorly connected punctures on a little more than apical third; oblique humeral stria finely impressed, joined basally with the first dorsal stria. Dorsal striae one to four complete, punctate, the outer two somewhat deeper than, and not quite as distinctly crenate as, three and four; the latter stria feebly inwardly arcuate at base; the fifth dorsal and sutural striae shallower than the others and possessing very strongly crenate margins; the fifth present on a little less than apical half, and represented by a coarse puncture at base; sutural stria abbreviated at basal third, approaching the suture on apical third.

Propygidium coarsely, densely, umbilicately punctate, the punctures separated by less than half their diameters. Pygidium very finely, exceedingly densely punctate throughout, with moderately coarse punctures intermingled, these latter about half the size of the propygidial punctures and rather dense, separated by about one to two times their diameters; marginal sulcus regular, evenly arcuate, inner margin crenate.

Prosternum as in generic description, the striae subjoined transversely at base, keel impunctate; lateral and approximate to the

carinal stria on each side at middle is a very short subcariniform lateral stria which feebly diverges and ascends anteriorly; prosternal lobe with a strong, complete, marginal stria, surface impunctate excepting a few moderately coarse punctures laterally near the suture.

Marginal mesosternal stria complete, joined on each side with a coarse, transversely, deeply arcuate stria behind the middle coxa which extends to the mesepimeral-metasternal suture. Meso-metasternal stria feebly crenate, anteriorly arcuate, departing halfway from the meso-metasternal suture to the marginal mesosternal stria and joining the lateral metasternal stria which extends nearly to the hind coxa. The metasternum indistinctly punctulate medially, but external to the lateral stria, on each side exceedingly coarsely punctate. First abdominal sternum longitudinally bistriate on each side within the coxa, the inner stria extending from basal margin nearly to the apical, the outer present on basal two-thirds.

Anterior tibiae with seven small teeth along the external margin, the basal five evenly spaced, a little more distant from the apical two; apex with two small spurs and fringed with smaller spur-like spinules; on the inferior surface of the anterior tibiae, parallel to, and close to the external margin is a row of short, rather stout spinules. Middle and posterior tibiae biseriately spinulose, the marginal row of the hind tibiae consisting of three or four rather widely separated spinules, the submarginal row of two or three more closely placed ones.

Measurements.—Length 3.2–3.4, width 2.0–2.15 mm.

Phelisteroides panamensis sp. nov. (pl. XIV, fig. 4; pl. XV; pl. XVI, figs. 1–3)

Type from Barro Colorado Island, Panama Canal Zone. In the collection of Field Museum of Natural History. Male. Collected from leaf mold, July 19, 1938, by Eliot C. Williams.

Allotype.—Same locality as the type. A female in the collection of Rupert L. Wenzel, collected from leaf mold, July 14, 1938, by Eliot C. Williams.

Paratypes.—Same data as the allotype. Two specimens of undetermined sex, one each in the collections of Field Museum of Natural History and Rupert L. Wenzel. One male, in the collection of Edward S. Ross. One female, same locality as the type, collected July 12, 1938, in the collection of Rupert L. Wenzel. All the paratypes were collected from leaf mold by Eliot C. Williams.

Description.—Form oblong-oval, moderately convex, distinctly depressed along the elytral suture. Color black with a faint tinge of brown, shining; legs, mouth parts, and antennae rufous. Head with supraorbital stria rather broadly interrupted at middle, not joined to the frontal stria, which is slightly abbreviated on each side and nearly straight and uninterrupted at middle. Front sparsely punctulate, broadly, rather shallowly impressed.

Pronotum about twice as broad as long, sides nearly straight and feebly convergent on basal two-thirds, thence more strongly arcuate and convergent to apical angles; anterior margin strongly emarginate, the median portion of the emargination distinctly outwardly arcuate; basal margin broadly arcuate. Marginal pronotal stria complete laterally, absent behind the head (complete in one specimen); lateral pronotal stria finely crenate, present around the anterior angles on each side and recurving behind the eyes, at which point it is narrowly interrupted on each side, the detached median portion being feebly arcuate with its ends strongly curving posteriorly. Surface sparsely punctulate throughout; on each side within the lateral stria is a rather broad area of coarse, elongate punctures.

Elytra together slightly broader than the pronotum, sides distinctly arcuate at base and apex, usually rather straight and feebly convergent on middle half; disks sparsely punctulate. Marginal elytral stria coarse, extending from base to apex. External subhumeral stria fine, crenate, abbreviated on basal third; internal subhumeral stria usually absent, sometimes represented by a few fine, linear punctures on apical third. Dorsal striae one to four well impressed, finely crenate; fifth dorsal extending from apex to a little beyond the middle, represented at base by a well-impressed puncture; sutural stria abbreviated at basal fifth; the fourth, fifth, and sutural striae much more distinctly crenate than the others.

Propygidium coarsely, umbilicately punctate, the punctures coarser at base and separated for the most part by one-half to three-fourths their diameters, the punctures finer at apex; very fine, sparse punctures scattered throughout. Pygidium very finely, shallowly, exceedingly densely punctate throughout, with moderately coarse punctures (about one-half the size of the coarse propygidial punctures) a little more densely placed along the basal margin, elsewhere sparse. Marginal sulcus coarse, deep, its outer margin rather coarsely crenated.

Prosternum as in generic description, the carinal striae fine, subcariniform, united transversely at base; keel nearly flat, micro-

scopically, sparsely punctate; prosternal lobe with a complete, well-impressed marginal stria, its surface sparsely punctulate medially, more coarsely so laterally.

Marginal mesosternal stria fine, joined posteriorly on each side to a coarser, transversely arcuate stria extending on each side behind the coxa to the mesepimeral-metasternal suture. The meso-metasternal stria is fine, crenate, strongly outwardly arcuate on middle two-thirds (subangulate at middle) and approaches the marginal mesosternal stria; laterally it is joined on each side with the fine lateral metasternal stria which extends posteriorly nearly to the hind coxa.

First abdominal sternum bistriate on each side within the hind coxa, the striae finely crenate, the innermost usually extending nearly to the apical margin, the outer usually extending a little beyond the middle and there curved and extending a short distance laterally.

Anterior tibiae with seven to eight small teeth, all the tibiae similar to those of *P. miladae.*

Measurements.—Length 2.65–3.25, width 1.75–1.95 mm.

Phelisteroides fungicolus sp. nov. (pl. XIV, fig. 6)

Type from Puerto Salgar, Colombia. In the collection of Field Museum of Natural History. Female. Collected July 31, 1938, by Henry S. Dybas (from fungus).

Paratypes.—Same data as the type. Three specimens of undetermined sex, two in the collection of Rupert L. Wenzel, one in the collection of Edward S. Ross.

Description.—Form oblong-oval, elytra feebly depressed along the suture. Color black, shining; legs, mouth parts, and antennae rufous. Head with supraorbital stria present at middle only, rather broadly interrupted on each side within the eyes or represented there by disconnected punctures; frontal stria complete, well impressed, subcariniform, finely crenate, rather evenly arcuate; front very shallowly impressed or not at all, sparsely punctulate.

Pronotum about twice as broad as long, sides nearly straight and moderately convergent on basal two-thirds, thence strongly arcuate and convergent to apical angles; anterior margin broadly, deeply, rather evenly emarginate. Marginal pronotal stria complete on each side, very broadly interrupted at middle (absent behind the head). Lateral pronotal stria complete, crenate, extending around the anterior angle on each side, thence feebly recurving and extending medially, narrowly interrupted on each side behind the eyes, the median detached portion straight and with its ends either posteriorly

recurving or simple. Disk sparsely punctulate throughout, with additional sparse, shallow, elongate, moderately coarse punctures on each lateral fifth within the lateral stria. Antescutellar impression small and shallow or absent.

Elytra together about twice as broad as long, sides very feebly arcuate except at base and apex. Marginal elytral stria deep, coarsely punctate, extending from base to apex. External subhumeral stria well impressed, punctate, very slightly abbreviated at base; internal subhumeral stria present on apical half; oblique humeral very finely impressed, long (present on a little more than basal third). Dorsal striae one to three well impressed, feebly punctate, complete; fourth, fifth, and sutural striae crenate, the fourth abbreviated on a little more than basal third, the fifth present in varying extent (apical third or half); the sutural stria varies from abbreviated on basal fourth to abbreviated on basal third. Elytral disks sparsely punctulate throughout.

Propygidium very coarsely, rather closely punctate, the punctures separated for the most part by less than half their diameters; sparse microscopical punctures intermingled with the coarser ones throughout, a row of moderate punctures present along lateral and apical margins. Pygidium extremely finely and densely, shallowly punctate, the punctures approximate to other coarser (but still fine) sparse punctures intermingled, these denser along the basal margin. Marginal sulcus deep and regular around apex, but deepening and strongly expanding basally to form a deep, tear-shaped excavation on each side.

Prosternum as in generic description, the striae finely subcariniform and not, or very finely, transversely united at base along the margin; external and nearly approximate to the carinal stria on each side at middle is another very fine, subcariniform, short, lateral stria; prosternal keel impunctate. Prosternal lobe with a well-impressed complete marginal stria, surface remotely punctulate, with a very few coarser punctures laterally. Anterior margin of mesosternum very broadly, almost imperceptibly emarginate; marginal stria well impressed, complete, joined posteriorly on each side to an arcuate stria as in *P. miladae* and *P. panamensis*. Meso-metasternal stria broadly, evenly arcuate along almost its entire breadth, the median portion approaching the marginal mesosternal stria; laterally the meso-metasternal stria is joined to the lateral metasternal stria, which extends nearly to the hind coxa.

Anterior tibiae six-denticulate, the basal and apical teeth extremely fine. Middle and posterior tibiae biseriately spinulose; the

marginal row of spinules on the hind tibiae three or four in number, these rather widely separated; the submarginal row consists of two or three more closely spaced spinules.

Measurements.—Length 2.4–2.6, width 1.6–1.75 mm.

The following key will serve to separate the species of *Phelisteroides:*

1. Dorsal striae 1–4 complete..2

1a. Dorsal striae 1–3 complete, the fourth at most extending a little beyond the middle..4

2. Marginal mesosternal stria present at sides only; frontal stria of head complete and joined to the supraorbital stria at the sides.
P. propygidialis Hinton (1935, p. 12); Mexico.

2a. Marginal mesosternal stria not interrupted at middle, complete; frontal stria of the head narrowly interrupted on each side, not joined to the supraorbital..3

3. Pygidium finely, extremely densely punctate, with moderately coarse punctures intermingled, these a little denser basally, elsewhere very sparse; marginal sulcus rather wide and deep, narrowest at apex; lateral pronotal stria interrupted on each side behind the eyes, so that the median portion is detached.
P. panamensis sp. nov.; Panama Canal Zone.

3a. Pygidium very finely, extremely densely punctate, with moderately coarse punctures intermingled, these latter rather dense, separated by 1–2 times their diameters; marginal sulcus regular and narrow; lateral pronotal stria not interrupted on each side behind the eyes...*P. miladae* sp. nov.; Colombia.

4. Pronotum impunctate laterally, marginal pronotal stria complete, pygidial sulcus not expanded and deepened basally on each side to form a tear-shaped excavation....................*P. pygidialis* Lewis (1908, p. 157); Paraguay.

4a. Pronotum with rather coarse, elongate punctures on each side within the lateral stria, marginal pronotal stria absent behind the head, pygidial sulcus expanded and deepened on each side to form a large, deep, tear-shaped excavation............................*P. fungicolus* sp. nov.; Colombia.

Pseudister mirabilis sp. nov. (pl. XIV, fig. 3)

Type from Puerto Salgar, Colombia. In the collection of Rupert L. Wenzel. Male. Collected July 31, 1938, by Charles H. Seevers from a rubbish heap of *Atta* sp.

Description.—Form oblong-oval; moderately convex. Color dark reddish-brown, shining. Surface finely, deeply, rather sparsely punctate throughout. Frontal stria of head fine, subcariniform, complete and feebly, irregularly arcuate anteriorly, continuous with the supraorbital stria. Front and epistoma somewhat flat. Labrum slightly broader than long, rounded anteriorly.

Pronotum about one-sixth broader than long, sides fairly straight and convergent on basal three-fourths, thence strongly arcuate to apical angles; basal width nearly twice that across apical angles. Marginal stria fine, but well impressed, interrupted behind the head for more than half the width of the head, somewhat sulciform near the median free ends; behind the head the marginal stria is replaced

by a transverse subcariniform stria (isolated apical portion of lateral pronotal stria) whose medial portion is fairly straight and close to the anterior margin of the pronotum, its free ends curving evenly posteriorly and ending laterally and posteriorly to the ends of the marginal stria. Lateral pronotal stria subcariniform, arising at the posterior angle of the pronotum close to the marginal stria and diverging gradually from it as it extends anteriorly; at about the middle its inner margin becomes confluent with a broad, shallow depression on each side; on the antero-medial edge of each depression is a blunt, posteriorly directed tubercle. On either side of the vague antescutellar impression anterior to the third dorsal elytral stria, a feeble impression extends anteriorly and medially about a fifth of the pronotal length before becoming obsolete.

Elytra together nearly one-fourth broader than long, near the middle distinctly broader than pronotum, sides evenly arcuate from base to apex. Epipleura bistriate (marginal epipleural and marginal elytral striae). External subhumeral stria extending from base to apex, narrowly interrupted at middle; internal subhumeral slightly abbreviated at base and apex. Dorsal striae one to five and sutural complete, strongly impressed, crenately punctate on about apical half, nearly impunctate on basal half; fifth dorsal stria united in a rather narrow arch with the sutural; first to fourth dorsals slightly hooked at base; extreme apices of fourth and fifth dorsals slightly abbreviated and confused with coarser punctures which are intermingled with the fine ground punctation.

Propygidium sparsely, moderately coarsely, umbilicately punctate. Pygidium with somewhat large punctures (though not as coarse as those of the propygidium) intermingled with the ground punctation.

Prosternal keel flat, sparsely punctulate; carinal striae subcariniform, closest anterior to middle, thence feebly divergent to apex where they are joined in a narrow arch, strongly divergent posteriorly, united along the posterior margin; lateral and approximate to the carinal stria on each side is a feeble, subcariniform, lateral prosternal stria which extends parallel to the carinal stria for the first third and diverges gradually, ending beyond the middle of the prosternum. Marginal stria of prosternal lobe subcariniform, interrupted at middle, strongly diverging from the margin and extending arcuately and posteriorly to near the base. Mesosternum broadly, feebly emarginate anteriorly, margined by a biarcuate subcariniform stria which terminates on each side at the medio-posterior border

of the middle coxa. Meso-metasternal stria feebly crenate, subcariniform, arcuate, joined on each side to the lateral metasternal stria which extends to the anterior margin of the posterior coxa.

Outer margin of anterior tibiae with seven moderate denticles. Middle and hind tibiae each with a few moderate spinules.

Measurements.—Length 2.0, width 1.5 mm.

Remarks.—This species cannot be related to any described *Pseudister*. The presence of two complete or nearly complete subhumerals, five complete dorsal striae, and a complete sutural stria is only occasionally met with in the family. This complement of elytral striae is elsewhere known to the writers in *Carcinops carinata* (described above), another new species of *Carcinops* to be described elsewhere, *Phelister completus* Schmidt, and a few other species. The paired antero-lateral pronotal impressions and tubercles seem to be unique. The impressions along the basal margin of the pronotum opposite the third dorsal stria are also found in some species of *Phelister*, for example, *P. subplicatus* Schmidt and *P. plicicollis* Schmidt.

Hister foveipygus sp. nov.

Type from Barro Colorado Island, Panama Canal Zone. In the collection of Rupert L. Wenzel. Male. Collected from leaf mold, July 20, 1938, by Eliot C. Williams.

Description.—Form oval, feebly convex, color black, shining. Surface feebly, minutely punctulate throughout. Front feebly impressed; head with supraorbital stria absent along the posterior margin of the vertex, present on each side as a short, longitudinal stria within the eyes which joins the frontal stria, this latter stria bisinuate, straight at middle. Mandibles rather short, blunt, without teeth along the inner margin.

Pronotum a little less than twice as broad as long, sides rather strongly convergent. Lateral pronotal stria complete, curving slightly inward at base on each side; marginal pronotal stria complete along the sides, extending around the apical angle on each side and interrupted behind the head.

Epipleural fossette with a fine, complete, subcariniform stria which continues over the humerus to base. Subhumeral striae absent; oblique humeral stria finely impressed; dorsal striae one and two complete, the third interrupted near apical fourth but continued by an apical appendix; dorsal striae four and five absent; sutural stria short, present from near middle to apical fifth.

Propygidium very coarsely, densely, foveolately punctate in a rather broad transverse area at middle on apical three-fifths, the area shallowly foveolately impressed on each side. Pygidium a little more coarsely punctate than propygidium in a roughly triangular area which approaches a trifoil shape on basal two-thirds.

Prosternum and lobe very finely, rather sparsely punctate. Carinal striae widely divergent at base, abbreviated a little beyond the middle; prosternal lobe strongly margined, the stria very narrowly interrupted at middle. Anterior mesosternal margin shallowly, narrowly emarginate; marginal mesosternal stria complete, not joined with the lateral metasternal stria.

Anterior tibiae with the external margin arcuate, without teeth or apical spurs. Middle tibiae feebly, biseriately spinulose. Posterior tibiae without spinules along the outer margin.

Measurements.—Length 5.3, width 3.4 mm.

Remarks.—This species belongs to the *coronatus-bullatus* section of the genus and may be separated from all the described species of this group by its non-dentate anterior tibiae and the entire absence of the fourth and fifth dorsal striae. The writers have not seen all the described related species but it is possible that the blunt, non-dentate mandibles are also a character unique to this species. The pronotum, in this section of the genus, does not actually have two lateral pronotal striae as one might assume from the descriptions of Marseul and Lewis; the external pronotal stria of these writers is actually the marginal pronotal stria.

Hister castaneus Lewis

Hister castaneus Lewis, Ann. Mag. Nat. Hist., (5), **15**, p. 465, 1885—Nicaragua (Chontales).

Colombia: Puerto Salgar, three specimens, July 29, 1938 (Dybas). Collected from a débris pile outside a nest of *Atta* sp.

Tribe Exosternini

The genus *Phelister* as now constituted contains at least several distinct groups of which one or two may eventually be separated as distinct genera. The genus is predominantly neotropical and is rich in number of species, about 135 having been described.

Phelister dives Marseul

Phelister dives Marseul, Ann. Soc. Ent. France, (4), **1**, p. 157, pl. 4, fig. 1, 1861—Brazil (Rio de Janeiro).

Colombia: Villavicencio, five specimens collected from under bark, July 11 and 25, 1938 (Seevers and Dybas).

Phelister williamsi sp. nov. (pl. XVI, figs. 7–9)

Type from Barro Colorado Island, Panama Canal Zone. In the collection of Field Museum of Natural History. Male. Collected from leaf mold, July 14, 1938, by Eliot C. Williams.

Allotype.—Same data as the type. A female in the collection of Rupert L. Wenzel.

Paratypes.—Same locality as the type, forty-nine specimens, collected July 9–20, 1938, by Eliot C. Williams; four each in the collections of Field Museum of Natural History, Edward S. Ross, Henry S. Dybas, and Eliot C. Williams; the remainder are in the collection of Rupert L. Wenzel.

Description.—Form rather roundly oval, distinctly convex. Color black with a feeble tinge of brown, shining. Upper surface very sparsely, distinctly punctulate throughout, the punctures of the pronotum variable, sometimes very deep. Front and epistoma distinctly concave. Supraorbital stria continuous with the fine, complete frontal stria.

Pronotum twice as broad as long, sides nearly straight and feebly convergent on basal two-thirds, arcuate and strongly convergent on apical third. Marginal pronotal stria very fine, extending around the anterior angle on each side and interrupted for nearly the entire width of the anterior pronotal emargination. Lateral pronotal stria present, finely punctate, complete behind the head and with a strong, moderately coarse puncture on each side behind the eye. Antescutellar impression rather large, oval.

Elytra together a little broader than long, at humeri one-eighth broader than pronotum, sides evenly arcuate from base to apex. Marginal epipleural stria absent. Marginal elytral stria well impressed and rather strongly punctate basally, very fine, impunctate, and nearly untraceable apically. External subhumeral stria finely punctate, present on apical half; internal subhumeral stria absent. Dorsal striae one to four rather finely impressed, finely punctate, the first often indistinct on apical half (represented there by a vague impression or row of feeble punctures); dorsal striae two to four extending from base to apical eighth; fifth dorsal stria variable, often represented apically only by a puncture or a short dash, sometimes extending nearly to middle, represented at base by a well-impressed puncture. Sutural stria well impressed, punctate, extending from near apex to a little beyond the middle or to basal third. Propygidium rather coarsely, sparsely punctate on basal half. Pygidium without coarser punctures.

Prosternum rather narrow, the carinal striae subparallel on apical half and joined in a rounded arch anteriorly; basally the striae are strongly divergent and may or may not be united; prosternal lobe with a coarse apical marginal stria.

Mesosternum very feebly produced at middle. Marginal mesosternal stria strongly impressed, complete, not joined to the lateral metasternal stria. Meso-metasternal stria anterior to the meso-metasternal suture for most of its extent, strongly impressed, arcuate but not strongly so, joined on each side to lateral metasternal stria.

Outer margin of anterior tibiae six-denticulate, the basal denticle minute. Middle tibiae with four to six spinules in a single row along outer margin. Hind tibiae with two or three fine spinules on outer edge near apex.

Measurements.—Length 1.6–2.0, width 1.1–1.3 mm.

Remarks.—*P. williamsi* runs to *globiformis* Marseul in Bickhardt's key (1917, p. 211) but is distinguishable from that species by its slightly smaller size, complete frontal stria, complete sutural stria, and the absence of a bent continuation of the fourth dorsal stria across the elytral base toward the scutellum.

Phelister latus sp. nov. (pl. XVI, figs. 13–15)

Type from the Satipo tropical rain forest, Dept. Junín, Peru. In the collection of Rupert L. Wenzel. Sex undetermined. Collected November, 1935, by Felix Woytkowski from a débris pile outside a nest of *Atta* sp.

Paratype.—Same data as the type. In the collection of Edward S. Ross.

Description.—Form broadly oblong, rather feebly convex, distinctly depressed along the suture and pronotal base. Color black, shining. Head sparsely, shallowly punctulate, frontal stria fine, complete; front concave.

Pronotum twice as broad as long, sides rather thick, not abruptly margined, evenly, distinctly arcuate on basal two-thirds, strongly arcuate and convergent on apical third; apical angles rather obtusely rounded. Surface sparsely, distinctly punctulate, with coarser punctures intermingled on the sides. Antescutellar impression distinct. Marginal pronotal stria complete, well impressed along the anterior margin, finely subcariniform along the sides, lateral pronotal stria absent.

Elytra two-sevenths broader than long, nearly one-seventh broader than pronotum; sides feebly arcuate at base, nearly straight

and feebly convergent at middle and beyond, arcuate and strongly convergent near apex. Surface sparsely punctulate. Marginal elytral stria subcariniform, coarsely punctate, extending from base to apex. External subhumeral stria deeply impressed, rather coarsely punctate, present on apical half. Dorsal striae feebly punctate, one to three complete; fourth dorsal extending a little beyond the middle, fifth present on apical half; sutural about equal to the fourth. Along the basal margin is a short transverse stria, extending from the region of the fourth dorsal to the sutural.

Propygidium deeply, rather sparsely punctulate throughout, with moderately coarse, sparse punctures intermingled. Pygidium a little more densely punctulate, with a few coarser punctures intermingled, these not as large as the coarser punctures of the propygidium.

Prosternal carina rather narrow; carinal striae nearly parallel on a little more than apical half and united in a narrow arch at apex, strongly divergent basally and imperfectly united along basal margin by variously connected punctures. A short lateral prosternal stria is present on each side external to the carinal stria on basal half. Apical margin of prosternal lobe with a deeply impressed stria. Mesosternum obtusely, not strongly, produced at middle; marginal stria broadly, strongly arcuate, subcariniform, continued posteriorly behind the middle coxae on the metasternum as an arcuate stria. Meso-metasternal stria subcariniform, distinctly crenate, broadly, rather strongly angulate at middle, extending halfway up the mesosternal disk, continuous on each side with the lateral metasternal stria, the latter rather straight and extending obliquely posteriorly nearly to the posterior coxa. Meso- and metasternal disks sparsely punctulate. First abdominal sternum on each side within the coxa, with a single oblique stria which extends halfway to apex.

Outer margins of anterior tibiae five to six denticulate, the two apical teeth rather large. Outer margins of middle and posterior tibiae with a submarginal row of small spines and a marginal row of six to seven longer spinules.

Measurements.—Length 2.6–2.7, width 2.04–2.1 mm.

Remarks.—This species runs to *pumilus* Erichson in Bickhardt's key (1917, p. 213) but lacks the five basal punctures at the end of the dorsal striae and is otherwise different; in form it resembles *P. amplistrius* Schmidt, but differs from that species in not possessing a subentire external subhumeral stria, in not having the elytral striae deeply crenate, and in having an arcuate marginal mesosternal stria and an angulate meso-metasternal stria.

Phelister parvulus Erichson

Hister parvulus Erichson, Jahrb. Ins., 1, p. 156, 1834.

Phelister acoposternus Marseul, Ann. Soc. Ent. France, (3), 1, p. 475, pl. 14, fig. 8, 1853.

Colombia: Villavicencio, one specimen, July 18, 1938 (Dybas).

Phelister quisquilicolus sp. nov. (pl. XVI, figs. 16–18)

Type from Puerto Berrio, Colombia. In the collection of Rupert L. Wenzel. Female. Collected August 5, 1938, by Henry S. Dybas, from a débris pile of *Atta* sp.

Description.—Form oval, moderately convex. Color reddish brown, shining, elytra with a tinge of black. Head moderately sparsely punctulate; supraorbital stria complete, continuous with the frontal stria, the latter rather broadly interrupted at middle, the free ends recurving slightly posteriorly. Front and epistoma not impressed. Anterior margin of labrum distinctly, arcuately emarginate.

Pronotum about twice as broad as long, sides nearly straight on basal two-thirds, strongly arcuate on apical third. Marginal stria well impressed, complete. Surface finely, rather sparsely punctulate, the punctures becoming coarser along the sides. Basal margin along middle two-thirds strongly crenate, the punctures elongate. Antescutellar impression distinct.

Elytra sparsely punctulate, together about four-fifths as long as broad at humeri, one-seventh broader than pronotum, sides evenly arcuate from base to apex. Marginal epipleural stria indistinct. Marginal elytral stria punctate, extending from base to apex, coarse near middle, its outer margin finely cariniform, crenated. External subhumeral stria punctate, distinctly impressed on a little more than apical half, continued to near base by a row of connected punctures, its outer margin very finely cariniform, the inner margin not defined. Dorsal striae well impressed, distinctly punctate and crenate; one to four complete, fifth extending to basal fourth and represented by a coarse puncture at base. Sutural stria complete, approaching the suture apically.

Propygidium sparsely punctulate throughout, with moderate punctures intermingled. Pygidium similarly punctate, the moderate punctures absent apically.

Prosternal keel rather narrow; carinal striae very finely cariniform, rather strongly divergent at base, parallel apically and extending anteriorly to the prosternal lobe; at the point where the carinal

striae diverge posteriorly, a short lateral stria arises on each side and ascends slightly, extending anteriorly a little beyond the middle, parallel to the carinal striae. Anterior margin of mesosternum straight; marginal mesosternal stria crenate, subcariniform, complete, continuing obliquely a short distance behind the middle coxa on the metasternum. Meso-metasternal stria subcariniform, strongly crenate, very feebly arcuate for its entire width, it being anterior to the meso-metasternal suture excepting at each end where it joins the lateral metasternal stria, the latter stria nearly straight and extending posteriorly to near the hind coxa. Meso- and metasternum feebly, microscopically rugulose, sparsely, shallowly punctulate; moderately coarse punctures present laterally on the metasternum within the lateral metasternal striae; external to the lateral metasternal stria the metasternum is coarsely, sparsely punctate. First abdominal sternum with two longitudinal striae on each side medial to the hind coxa.

Outer edge of anterior tibiae arcuate, armed with eight spine-like denticles of which the basal one is minute, the others becoming rather long apically. Middle and posterior tibiae with a submarginal row of seven or eight spines and a marginal row of eight long spines.

Measurements.—Length 2.75, width 1.75 mm.

Remarks.—This species seems to be most closely allied to *P. rubens* Marseul, but differs in having the external subhumeral stria continued to base by row of punctures, in having the sutural stria complete, the fourth and fifth dorsal striae not united at apex, and in the possession of lateral prosternal striae in addition to the carinal striae. Since there is often considerable variation in the extent of the fifth and sutural striae in many species of *Phelister,* these characters may not be valid for separating the two species; however, the presence of distinct lateral prosternal striae could hardly have been overlooked by Marseul. Actually *quisquilicolus* runs to *fulvulus* Marseul in Bickhardt's key (1917, p. 212) but differs from this species also in possessing lateral prosternal striae and in its longer sutural stria and punctate pygidia.

Phelister purgamenticolus sp. nov.

Type from Puerto Berrio, Colombia. In the collection of Rupert L. Wenzel. Female. Collected August 5, 1938, by Henry S. Dybas from a débris pile of *Atta* sp.

Description.—Similar to *P. quisquilicolus* but differs chiefly as follows: Head more sparsely punctate, frontal stria complete; front and epistoma slightly concave. Elytral striae more finely punctate,

subhumeral stria represented only on a little more than apical half, not continued basally by punctures; fifth dorsal stria abbreviated at middle, sutural stria extending to basal third. Propygidium less obviously punctulate, the coarser punctures about twice the size of those of *quisquilicolus*. Prosternum with a few setigerous punctures on basal half; the setae appear to be somewhat squamous as though modified as trichomes; two elongate punctures along the median line bear "tufts" of setae. Mesosternum with somewhat sparse, similar setigerous punctures. Meso- and metasternum not microscopically rugulose. Metasternum with a few somewhat coarser punctures within the lateral striae as in the above species.

Measurements.—Length 2.2, width 1.6 mm.

Remarks.—The presence of setigerous punctures on the pro- and mesosternum of *P. purgamenticolus* immediately distinguishes it from *P. quisquilicolus*.

Phelister recrementicolus sp. nov.

Type from Puerto Salgar, Colombia. In the collection of Field Museum of Natural History. Male. Collected July 31, 1938, by Charles H. Seevers from a rubbish heap of *Atta* sp.

Paratypes.—Same data as the type. Two males, one each in the collections of Rupert L. Wenzel and Edward S. Ross.

Description.—Closely allied to *P. purgamenticolus* but differing as follows: Front and epistoma rather flat (not concave), frontal stria broadly interrupted. Lateral punctures of pronotum finer and very sparse, nearly absent. External subhumeral stria of elytra as in *P. quisquilicolus*. Sutural stria complete or interrupted at basal fourth and represented at base by an arcuate striole. Coarser punctures of propygidium much finer, like those of *quisquilicolus*. Pygidium without any appreciably coarser punctures mingled with the punctulation.

Measurements.—Length 2.1–2.3, width 1.55–1.6 mm.

Remarks.—*P. recrementicolus* may possibly be the male of *purgamenticolus* but the differences between the two are not those usually associated with secondary sexual characters.

Phelister striatinotum sp. nov.

Type from Villavicencio, Colombia. Sex undetermined. In the collection of Rupert L. Wenzel. Collected July 24, 1938, by Henry S. Dybas.

Description.—Form elongate-oval, moderately convex. Color reddish brown, shining. Head rather sparsely punctulate. Epistoma

distinctly concave. Frontal stria complete, subcariniform, well impressed, not connected with the fine, feebly subcariniform supra-orbital stria.

Pronotum about twice as broad as long, sides nearly straight on basal two-thirds, thence arcuate to apical angles. Marginal stria complete, well impressed. Lateral striae absent. Surface rather sparsely punctulate, with coarser, shallow punctures intermingled along the sides. Base of pronotum with a very shallow, transverse area set off by a fine, subcariniform, continuous stria which arches on each side from basal margin opposite the fourth elytral stria to basal fifth and extends transversely with a feeble outward angulation at middle. Punctures along basal margin rather feebly impressed.

Elytra sparsely punctulate (epipleura smooth), together about two-thirds as long as broad, at humeri distinctly broader than pronotum, sides rather evenly arcuate from base to apex. Marginal epipleural stria absent. Marginal elytral stria complete from base to apex, coarse, its outer margin cariniform, crenate along basal third. External subhumeral stria complete, subcariniform, crenate, feebly, inwardly angulate just beyond the middle. Oblique humeral stria indistinct. Dorsal striae one to four complete, fourth arching at base and joining the sutural, which is narrowly interrupted near basal fifth or sixth; fifth dorsal stria extending to basal third; dorsal striae one to four have the outer margins subcariniform, finely crenate, inner margins rather indistinct; the fifth and sutural striae are more distinctly punctate (sutural stria rather strongly crenate) and have both the outer and inner margins distinct, not subcariniform.

Propygidium sparsely punctulate with a few moderate punctures intermingled. Pygidium sparsely punctulate.

Prosternum distinctly, angulately incised at base, keel rather narrow, impunctate; carinal striae finely cariniform, parallel on about apical two-thirds, united anteriorly in a rounded arch, strongly divergent and not united posteriorly. Prosternal lobe sparsely punctulate, apical margin subtruncate, marginal stria well impressed, complete. Mesosternum with the anterior margin acutely produced at middle; marginal mesosternal stria coarsely subcariniform, crenate, broadly arcuate (angulate at middle). Meso-metasternal stria coarsely subcariniform, crenate, angulately arching halfway up the mesosternal disk, connected on each side with the lateral metasternal stria, which is coarsely subcariniform, impunctate, and extends obliquely and posteriorly to the anterior margin of the hind coxa. Behind the middle coxa is a short, arcuate stria. Disks of meso-

and metasternum and first abdominal sternum sparsely punctulate. First abdominal sternum bistriate on each side medial to the hind coxa, the inner stria subsulciform, crenate, extending from basal to apical margin, the outer stria very short, basal.

Outer margin of anterior tibiae arcuate, bearing seven or eight spine-like teeth, of which the middle three are strong, prominent, the others successively shorter; tarsal groove straight. Outer edge of middle tibiae with a marginal row of seven or eight slender spinules (of which the apical six are rather long as in *P. latus*) and a submarginal row of seven to eight very short spinules. Outer edge of posterior tibiae with a marginal row of five to six slender spinules on apical half and one or two short submarginal spinules near apex.

Measurements.—Length 2.53, width 1.83 mm.

Remarks.—This very distinct new species runs to *P. fulvulus* Marseul in Bickhardt's key (1917, p. 212) but may readily be separated from that species by its complete frontal stria, the presence of an antescutellar stria on the pronotum, the strongly incised prosternal base (truncate in *fulvulus*), and the extent of the fourth dorsal and sutural striae. This species is the only *Phelister* yet seen by the writers which has an acute production of the anterior mesosternal margin as in certain other Exosternini. The antescutellar pronotal impression and stria seem to be unique in the genus thus far and recall the structure found in such species of *Epierus* as *E. epulo* Marseul, *E. coproides* Marseul, and *E. schmidti* sp. nov.

Phelister flectohumerale sp. nov. (pl. XVI, figs. 4–6)

Type from Puerto Berrio, Colombia. In the collection of Field Museum of Natural History. Male. Collected August 5, 1938, by Henry S. Dybas from a rubbish heap of *Atta* sp.

Allotype.—Same data as the type. A female in the collection of Rupert L. Wenzel,

Paratypes.—Seven specimens, same data as the type; one in the collection of Field Museum of Natural History, six in the collection of Rupert L. Wenzel. From Puerto Salgar, Colombia, nine specimens, one each in the collections of Field Museum of Natural History and Edward S. Ross, seven in the collection of Rupert L. Wenzel; collected July 31, 1938, by Henry S. Dybas from a rubbish heap of *Atta* sp.

Description.—Form oval, moderately convex. Color black, shining; surface rather deeply, somewhat sparsely punctulate throughout. Frontal stria of head subcariniform, interrupted at middle, its median free ends incurving; supraorbital stria not con-

nected with the frontal stria; front and epistoma rather strongly concave.

Pronotum nearly twice as broad as long, sides feebly and evenly curved to apical fourth, thence more strongly curved to the anterior angles. Marginal stria fine and complete, lateral stria absent. Coarser (but fine) punctures are intermingled laterally with the punctulation. Antescutellar impression present.

Elytra together about two-thirds as long as broad, at humeri distinctly broader than pronotum, sides arcuate near base and apex, somewhat straight near middle. Internal subhumeral stria absent; external subhumeral represented on apical half of elytra, broad, crenately punctate; anterior to the middle of the elytron it bends sharply inward at right angles for a short distance and becomes fine, subcariniform. Dorsal striae well impressed, punctate, the fourth, fifth, and sutural striae a little more distinctly crenate than the others; dorsals one to four complete, fifth usually abbreviated on a little less than basal half, frequently extending to basal third or fourth, represented by a deep puncture at base; sutural stria usually complete, occasionally abbreviated at about basal sixth.

Propygidium and pygidium rather densely punctulate throughout with moderate punctures intermingled, these distributed rather evenly on the propygidium (though finer medially and apically) and on the pygidium distinctly finer and sparser on the apical half.

Posterior margin of prosternum with a fine, short, transverse stria; keel narrow, the carinal striae subcariniform and subparallel anteriorly (where they unite in a narrow arch); posteriorly they are strongly divergent, broad and shallow, not united. The character of the carinal striae is somewhat variable in the type series, the anterior union varying from acute to rounded (not united at all in one paratype), and the width between the striae is not uniform; in one paratype the stria of one side continues along the posterior margin of the prosternum and nearly joins the other. Marginal stria of prosternal lobe usually complete but narrowly interrupted at middle in a few examples. Mesosternum feebly bisinuate in front, marginal stria subcariniform, continued on each side behind the middle coxa on the metasternum. Meso-metasternal stria subcariniform, irregularly crenate, and produced anteriorly at middle to form a sharp, obtuse angle in some specimens, irregularly rounded in others. Lateral metasternal stria subcariniform, broadly, shallowly punctate, angulately united with the meso-metasternal stria and extending posteriorly and laterally to posterior third of the meta-

sternum where it recurves broadly to extend along the lateral margin of the metasternum to the mesepimeral-metasternal suture. First abdominal sternum with two striae on each side medial to the hind coxa, the outer longitudinal and extending from base to apex, the other curved, short, transverse, extending behind the coxa.

Outer margin of anterior tibiae six-denticulate, the first and sixth denticles minute, the second to fourth strong and prominent, the fifth rather small. Middle tibiae with from six to eight spines on outer margin. Hind tibiae with a few spines on outer margin of apical half, the spines increasing in size apically.

Measurements.—Length 3.0–3.75, width 2.0–2.5 mm.

Remarks.—*P. flectohumerale* runs to *muscicapa* Marseul in Bickhardt's key (1917, p. 213), but differs from that species and all others known to the writers in the nature of the external subhumeral stria, which is bent abruptly inward near the middle of the elytron.

Phelister assimilis sp. nov. (pl. XVI, figs. 10–12)

Type from Puerto Berrio, Colombia. In the collection of Field Museum of Natural History. Male. Collected from cow dung August 5, 1938, by Henry S. Dybas.

Allotype.—Same data as the type. A female in the collection of Rupert L. Wenzel.

Paratypes.—Same data as the type, four specimens in the collection of Rupert L. Wenzel. From Villavicencio, Colombia, two specimens in the collection of Field Museum of Natural History, and one each in the collections of Edward S. Ross and Rupert L. Wenzel. Collected from cow dung July 11, 1938, by Henry S. Dybas.

Description.—Form oval, moderately convex. Color black, shining. Upper surface distinctly, rather sparsely punctulate throughout. Frontal stria of head deeply impressed, present on each side only as a longitudinal interocular stria medial to the eye, not joined to the fine, feebly impressed supraorbital stria. Front and epistoma rather strongly concave.

Pronotum nearly twice as broad as long, sides on basal half fairly straight, thence arcuate and strongly converging to apical angles. Marginal stria well impressed, complete. Lateral stria absent. Antescutellar impression well defined. Pronotum with moderately coarse, rather sparse punctures intermingled with the punctulation in a broad area on each side.

Elytra together about one-eighth broader than long. Marginal elytral stria well marked, complete, rather wide, indistinctly cre-

nately punctate. External subhumeral stria represented on apical two-thirds by a broad well-impressed subcrenately punctate stria; internal subhumeral usually absent, indicated on a few examples by a short, apical impression. Dorsal striae one to four well impressed, crenately punctate, complete; fifth dorsal present on apical half or less, represented by a prominent rounded impression at base; sutural stria variously interrupted within basal third.

Propygidium with rather coarse, moderately sparse punctures intermingled with the punctulation, the punctures becoming finer near apex. Punctation of pygidium basally similar to that of apex of propygidium; apically the pygidium is punctulate only.

Prosternum finely, distinctly, moderately, sparsely punctulate; keel flat, rather broad; carinal striae rather widely separated, subparallel on anterior half (feebly, outwardly arcuate in some specimens), divergent on posterior half, not united at either end. Marginal stria of prosternal lobe well impressed, complete. Mesosternum with punctation similar to that of prosternum; anterior margin feebly produced at middle; marginal stria coarse, subcariniform, feebly crenate, somewhat angulately or arcuately produced at middle, terminating on each side near the middle of the inner margin of the middle coxa. Meso-metasternal stria coarse, subcariniform, strongly crenate, broadly, angulately, or arcuately produced at middle, joined on each side with the lateral metasternal stria which extends posteriorly to the hind coxa; from the junction of the meso-metasternal and lateral striae a fine subcariniform stria extends obliquely on each side to or near the middle coxa, then bends posteriorly and extends around the posterior margin of the coxa as a coarse, subcariniform, crenately punctate stria and becomes obscured in the heavy, coarse punctures of the metasternum near the mesepimeral-metasternal suture. First abdominal sternum with a well-impressed oblique stria on each side medial to the hind coxa, the stria extending to the posterior margin of the sternum.

Outer margin of anterior tibiae bearing six or seven rather slender denticles. Outer edge of middle tibiae with a marginal row of six or seven spinules and a submarginal row of several very short spinules. Hind tibiae with a few smaller spines on apical half of outer margin.

Measurements.—Length 2.4–3.0, width 1.7–2.0 mm.

Remarks.—*P. assimilis* runs to *panamensis* LeConte in Bickhardt's key (1917, p. 214) but differs from that species in having the front of the head rather strongly concave and in having the marginal meso-

sternal and the meso-metasternal striae either arcuate or angulate at middle rather than straight as figured by Lewis (1888, pl. 5, fig. 2); furthermore, the stria which extends obliquely from the junction of the meso-metasternal and lateral metasternal striae is apparently not present in *panamensis*. The original description of the last-named species is not diagnostic for any *Phelister*, and were it not for Lewis' figure of the under side (from a specimen compared with an example sent by LeConte to Marseul) the identity of *panamensis* would remain entirely obscure; it is unfortunate that Lewis did not give further diagnostic characters other than those to be garnered from his illustration.

Phelister egenus Marseul

Phelister egenus Marseul, Ann. Soc. Ent. France, (3), 1, p. 480, pl. 14, fig. 12, 1853—Colombia and Venezuela.

Colombia: Puerto Berrio, seventy specimens, from cow dung, August 5, 1938 (Dybas).

Phelister pusio Erichson

Phelister pusio Erichson, Arch. für Naturg., (1), 13, p. 91, 1847.

Phelister pusio Marseul, Ann. Soc. Ent. France, (3), 1, p. 472, pl. 14, fig. 5, 1853—Brazil (Bahia).

Colombia: Villavicencio, one specimen from cow dung, July 18, 1938 (Dybas).

Phelister quadripunctulus Marseul

Phelister quadripunctulus Marseul, Ann. Soc. Ent. France, (3), 1, p. 471, pl. 14, fig. 4, 1853—Venezuela (Caracas).

Colombia: Villavicencio, twenty specimens collected in horse manure, July 11, 1938 (Dybas).

Phelister cumanensis Marseul

Phelister cumanensis Marseul, Ann. Soc. Ent. France, (3), 1, p. 470, pl. 14, fig. 3, 1853—Venezuela (Caracas).

Colombia: Puerto Berrio, one specimen from cow dung, August 5, 1938 (Dybas).

Phelister chapadae Lewis

Phelister chapadae Lewis, Ann. Mag. Nat. Hist., (7), 5, p. 227, 1900—Brazil.

Colombia: Villavicencio, one specimen, July 25, 1938 (Dybas).

Subfamily **Hetaeriinae**

Tribe **Hetaeriomorphini**

Poneralister manni sp. nov.

Type from Tumupasa, Bolivia. No. 54,976 in the collection of the United States National Museum. Male. Collected December, 1921, by William Mann.

Description.—Form oval, strongly convex. Color black, subopaque. Supraorbital stria of head represented by a row of coarse, elongate punctures as in *P. striaticeps* Bruch. Lateral margin of head carinulate on each side from the eye to the anterior margin of the epistoma; front with 15 or 16 fine longitudinal striae, these finely, sparsely punctate.

Pronotum nearly twice as broad as long, sides nearly straight and strongly converging to apical angles which are transversely truncated. Marginal stria extremely fine; a single, finely cariniform lateral pronotal stria, which is close to the marginal, extends on each side from basal margin to around the truncated anterior angle and is broadly interrupted behind the head. Closely placed, parallel, fine, longitudinal striae extend from basal to apical margin, excepting a sparsely, moderately punctate area along basal fourth at middle; the striae are very finely punctulate, the punctures not being large enough to give the striae a crenate appearance.

Elytra together, about one-fourth again as broad as pronotum; sides evenly arcuate, apices transversely truncated. Disks of elytra evenly, rather closely (the punctures separated by about one-half their diameters), moderately coarsely punctate throughout, the punctures finely ocellate, the inner punctures located anteriorly within the larger punctures. Epipleural fossette sharply separated from the rest of the epipleuron and possessing a single fine stria. Elytral striae finely subcariniform; marginal elytral stria strongly angulate near middle, complete. External subhumeral present on basal three-eighths, close to and parallel to the basal portion of the marginal elytral stria; internal subhumeral complete. First dorsal stria extending from basal fourth to apex and recurving inwardly for a short distance along apical margin.

Propygidium slightly more sparsely punctate than the elytra. Pygidium subcircular, its punctation like that of the propygidium, but finer at apex; both the propygidium and pygidium are more shining than remainder of body.

Prosternum as in *P. striaticeps* Bruch, narrow within the striae, the striae joined in front. Mesosternum deeply, moderately,

coarsely, rather closely punctate; anterior margin produced at middle and not margined; marginal stria represented on each side near anterior margin by a scarcely distinguishable impression composed of coarse, disconnected punctures. Meso-metasternal suture not distinct, feebly impressed. Metasternum extremely coarsely punctate, the punctures becoming smaller (though still coarse) laterally. Lateral metasternal stria distinct, subsulciform. First abdominal sternum sparsely, rather finely punctate, the punctures elongate, sublinear.

Anterior tibiae as in *P. striaticeps* Bruch, but with the emargination of the outer edge very feeble and the teeth extremely minute. Middle and posterior tibiae rather broadly expanded, their outer margins angulate at middle (not acutely) and without any indication of teeth or spines.

Measurements.—Length 1.95, width 1.5 mm.

Remarks.—*P. manni* may easily be distinguished from *P. striaticeps* Bruch (1929, p. 426) as follows:

P. manni sp. nov.	*P. striaticeps* Bruch
Head with 15–16 longitudinally impressed striae.	Head with 24–25 striae.
Sutural stria of elytra absent, indicated by a vague impression.	Elytra with a distinct, fine, subcariniform sutural stria.
Mesosternum without a distinct marginal stria.	Marginal mesosternal stria complete, well impressed.
Teeth of anterior tibiae distinct; middle and posterior tibiae without teeth or spines.	Teeth of anterior tibiae minute; middle and posterior tibiae "fein gezahnt und bebostet."

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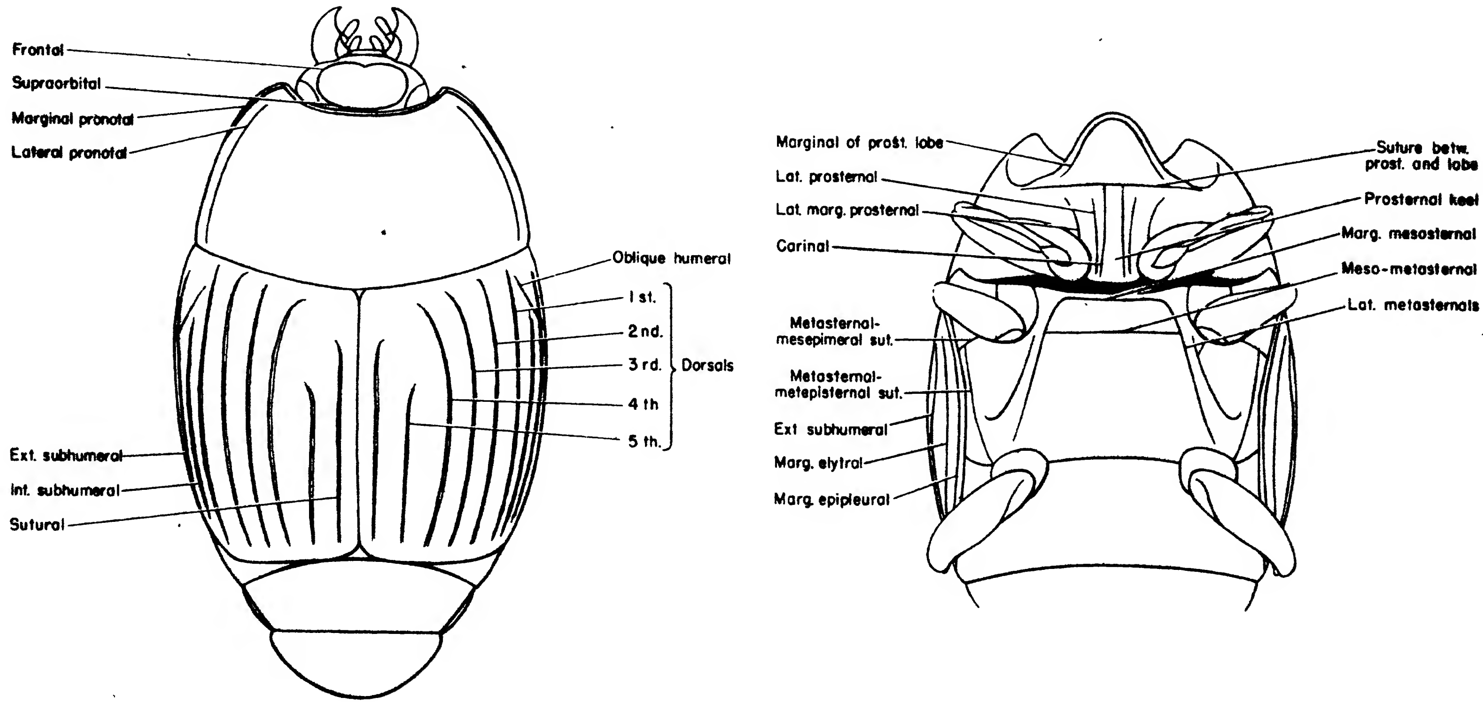
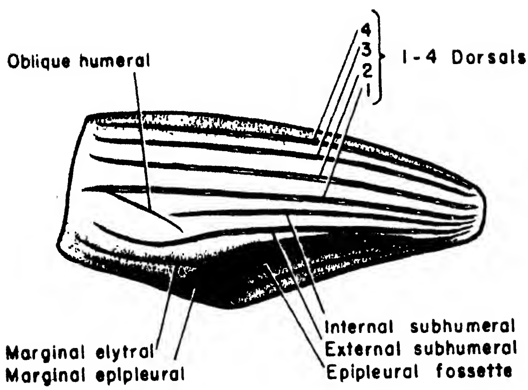


DORSAL AND VENTRAL VIEWS OF AN HISTERID SHOWING PRINCIPAL STRIAE AND SUTURES



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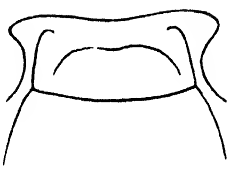

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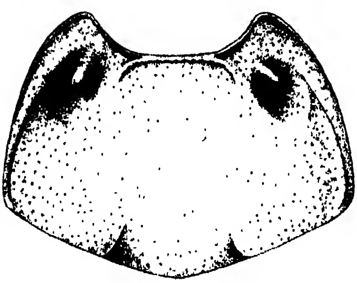

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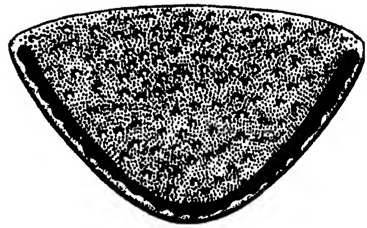

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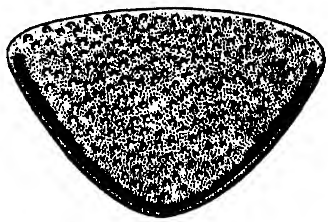

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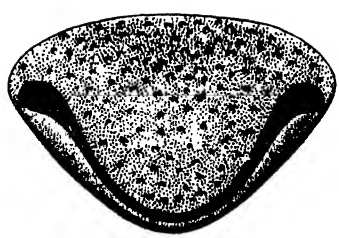
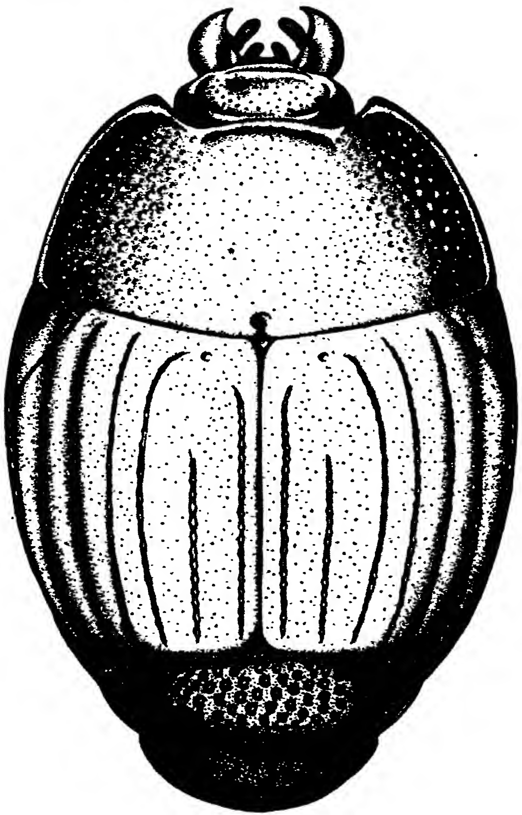
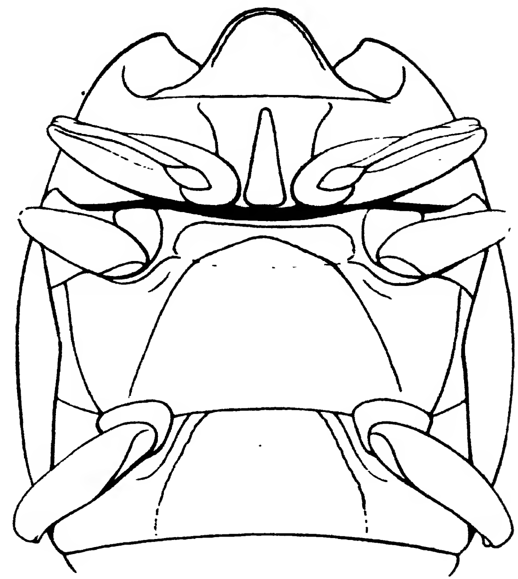


6

STRUCTURES OF NEOTROPICAL HISTERIDAE

Fig. 1. Lateral view of an histerid elytron showing striae of flank and epipleuron. Fig. 2. *Carcinops biinterrupta* sp. nov., mesosternum. Fig. 3. *Pseudister mirabilis* sp. nov., pronotum. Fig. 4. *Phelisteroides panamensis* sp. nov., pygidium. Fig. 5. *Phelisteroides miladae* sp. nov., pygidium. Fig. 6. *Phelisteroides fungicolus* sp. nov., pygidium





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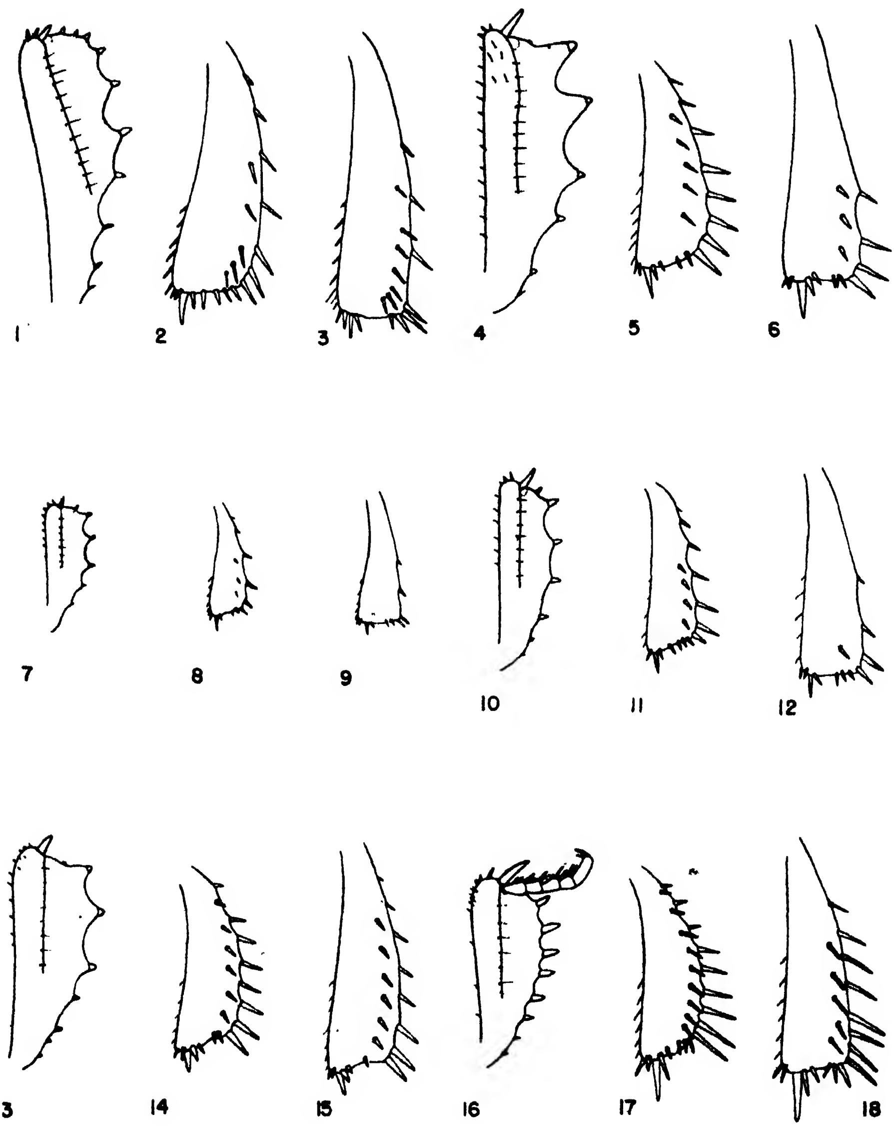
PHELISTEROIDES PANAMENSIS SP. NOV.

Fig. 1. Dorsal view. Fig. 2. Ventral view, showing gross structure



INNER FACES OF PROTIBIAE, OUTER FACES OF MESO- AND METATIBIAE

Figs. 1–3. *Phelisteroides panamensis* sp. nov. Figs. 4–6. *Phelister flectohumerale* sp. nov. Figs. 7–9. *Phelister williamsi* sp. nov. Figs. 10–12. *Phelister assimilis* sp. nov. Figs. 13–15. *Phelister latus* sp. nov. Figs. 16–18. *Phelister quisquilicolus* sp. nov.

THE AMPHIBIANS AND REPTILES OF BRITISH HONDURAS

BY

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THE AMPHIBIANS AND REPTILES OF BRITISH HONDURAS

BY KARL P. SCHMIDT

An account of the reptiles and amphibians of British Honduras is part of a program of research on the herpetological fauna of upper Central America proposed for Field Museum on the occasion of my joining the Museum's Department of Zoology in 1922. This project was greatly furthered by the grant of a fellowship of the John Simon Guggenheim Memorial Foundation in 1932, which made possible a visit to European museums in that year. Knowing of the plan for an account of the amphibians and reptiles of British Honduras, colleagues have reserved collections from that country for my study and, while I owe them some apology for the long delay in publishing, the continued addition of specimens has made it difficult to close the manuscript. The prospect of still further additions is such that I now present only an annotated list.

Present published knowledge of the herpetological fauna of British Honduras rests on scattered information in the Biologia Centrali-Americana (supplemented by the references and corrections in Boulenger's catalogues of the collections in the British Museum) and on similar records of the Mission Scientifique au Mexique. The only paper referring specifically to the reptiles of British Honduras is Cope's brief list of the Parsons collection in the United States National Museum.

I am indebted to the authorities of the British Museum (Natural History), and especially to Mr. H. W. Parker and his aid, Mr. J. C. Battersby, for the privilege of examining their British Honduran material, amounting to about sixty specimens. Dr. Fernand Angel most kindly placed the corresponding collections at the Museum d'Histoire Naturelle in Paris at my disposal. The collection of 124 specimens from British Honduras in the United States National Museum also has been available for examination, thanks to the courtesy of Dr. Doris M. Cochran.

The Marshall Field Expedition to Central America in 1923, composed of Mr. Leon L. Walters and myself, visited British Honduras and Honduras in search of amphibians and reptiles for exhibition and study. Five weeks, from January 24 to March 1, 1923, were spent in British Honduras. Our reception by the government offi-

cials at Belize was most cordial. We are especially indebted to Mr. Robert Masson and to Dr. and Mrs. John Peach for friendly aid and advice. Through the courtesy of Mr. J. E. Freeman, Belize agent for the United Fruit Company, and Mr. J. A. Price, the Stann Creek agent, the abandoned guest house of the United Fruit Company at Middlesex was placed at our disposal. Collections amounting to 441 specimens were made principally at Middlesex, which is near the center of the colony, and in the environs of Belize, with a few specimens from Stann Creek, a few from the Forest Reserve sixteen miles from Stann Creek, and a few from Tom Owen Cay. The rediscovery of Morelet's crocodile, the existence of which as a distinct species had come to be doubted, has been reported in a previous publication (Schmidt, 1924).

Through the friendly interest of the teachers and officers of St. John's College, at Belize, 94 specimens of amphibians and reptiles were presented to Field Museum. These were the remnant of collections made by W. A. Stanton, S. J., during the years of his residence in British Honduras; a few specimens collected by him also reached the United States National Museum, and it is reasonable to suppose that the material from British Honduras in the Hurter Collection was also collected by Stanton, since he came from St. Louis and was thus doubtless acquainted with Mr. Hurter. A further addition of 93 specimens to the British Honduran collections in Field Museum is due to the efforts of Professor B. H. Bailey, of Coe College, Iowa. Professor Bailey, a student of the late S. E. Meek of the Field Museum Staff, collected at Manatee, between Belize and Stann Creek, in June, 1905.

The Mandel Caribbean Expedition of Field Museum, sailing on the yacht *Buccaneer* of Mr. Leon Mandel, passed through British Honduran waters in January, 1940, stopping at Half Moon Cay, Glover's Reef, and Turneffe Islands. The collections of reptiles obtained by Messrs. Rudyerd Boulton and D. Dwight Davis, of the Museum Staff, amount to 122 specimens. This brings the total number of specimens from British Honduras in Field Museum to 750. In the lists of specimens below, Field Museum numbers are written without initials.

Collecting expeditions to British Honduras from other institutions have added steadily to available material. Messrs. Josselyn Van Tyne and Adolph Murie collected 17 specimens in British Honduras on their trip into the Peten (primarily for birds and mammals, for the University of Michigan) in 1931; Dr. L. C. Stuart, also of the

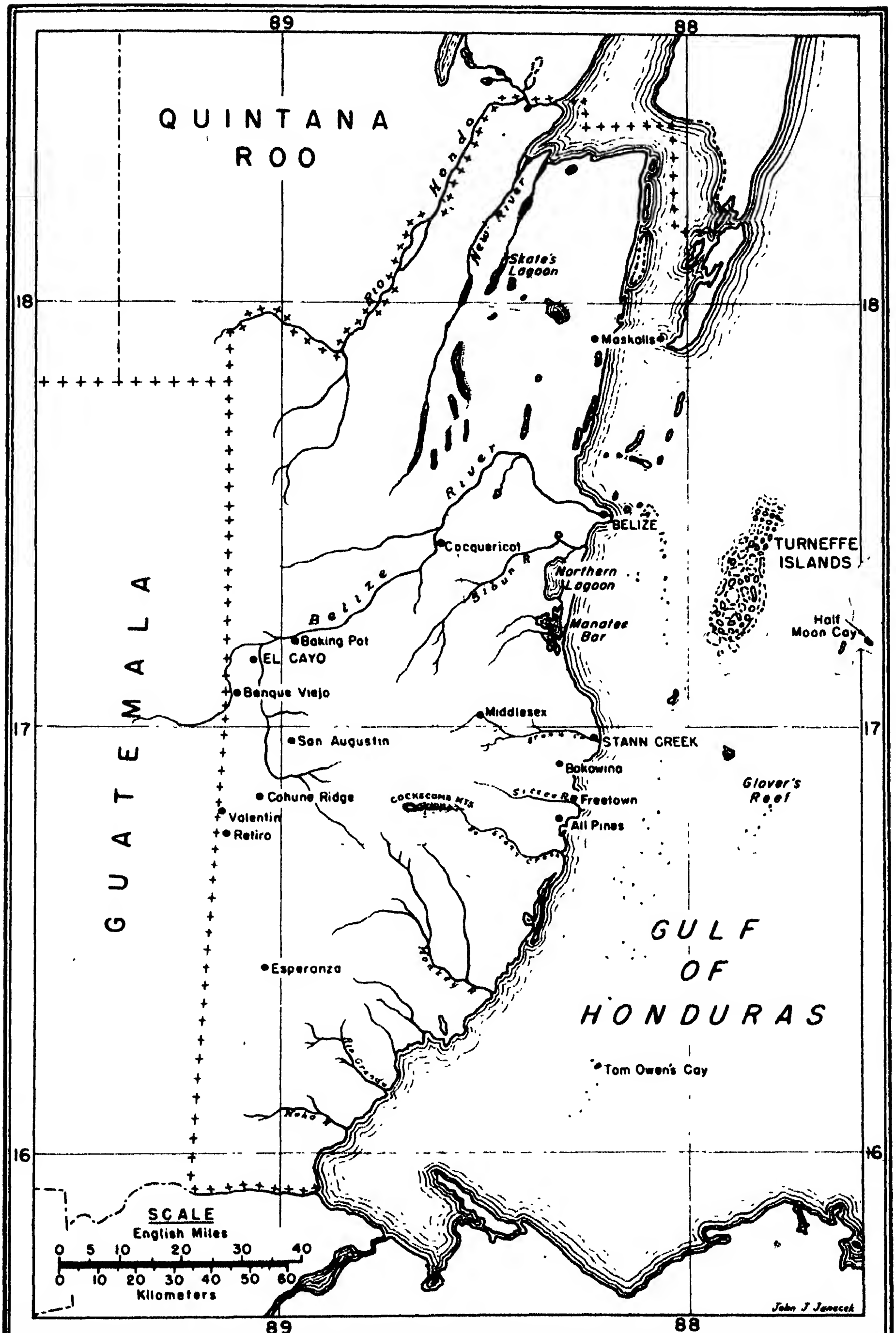

FIG. 38. Map of British Honduras, showing localities mentioned in the text.

University of Michigan, and similarly on his way to the Peten region, collected 15 specimens at Belize and Cocquericot; and Dr. C. L. Lundell supplemented this small nucleus with 177 specimens which were a by-product of his botanical field work of 1936. These collections were made available to me by Mrs. Helen T. Gaige, Curator of Reptiles of the Museum of Zoology at the University of Michigan, to whom I am also much indebted for aid in identifying the tree frogs of the collection.

Meanwhile, in 1935, Messrs. Emmet R. Blake and Charles T. Agostini made an ornithological expedition to British Honduras for the Carnegie Museum. Their objective was the Cockscomb Mountains, the highest terrain in the colony, which accordingly offered some chance of finding endemic forms. Their collection of reptiles and amphibians, made under considerable difficulties, amounts to 182 specimens. In lending this material for examination, Mr. M. Graham Netting kindly included five specimens of lizards from Half Moon Cay, off the coast of British Honduras. These specimens were collected by Mr. Ernest G. Holt in 1926, on the occasion of a visit to the island for a habitat group of man o' war birds. Two of these lizards represent the remarkable *Anolis allisoni*, a species representative of the Cuban *porcatus* group.

I am indebted to Mr. Benjamin Shreve, of the Museum of Comparative Zoology, for the list of their British Honduran reptiles, which number 10 specimens, representing five species.

Most recently, a collection of amphibians and reptiles made by Mr. Ivan T. Sanderson and his party in British Honduras has been deposited in Field Museum and made available for study in the present connection. This important collection includes 513 specimens and adds five species to the fauna hitherto known. The identifications used in the present list were supplied to Mr. Sanderson and are employed by him in his recently published book, "Living Treasure."

The accumulated collections from these varied sources thus amount to more than 1,600 specimens; this is still entirely inadequate for a knowledge of the distribution of the species within the colony, and many species are still represented by only one or two specimens. Further additions to the fauna obviously may be expected, since there are still numerous species known from adjacent Peten which have not been recorded from British Honduras (see below). The species thus far known are 98 in all: 2 salamanders, 15 frogs and toads, 8 turtles, 2 crocodilians, 33 lizards, and 38 snakes.

The faunal region to which British Honduras belongs is referred to as the Peten Province by Hobart M. Smith, in his important study of the distribution of the Mexican and Central American lizards of the genus *Sceloporus*. This province includes essentially the base and the middle portion of the Yucatan Peninsula—all of British Honduras, the Guatemalan department of Peten, and the Mexican state of Campeche and territory of Quintana Roo. The province as a whole is distinguished by high tropical rain-forest. Stuart (1935) gives a general geographic account of Peten, much of which is applicable to the region as a whole. His several papers on this adjacent region have been especially useful in the preparation of the present report. The nature of the British Honduran collection here reported upon makes it impossible to analyze the fauna ecologically as Stuart has analyzed that of Peten in his field studies of the Peten savannas. British Honduras is apparently like Peten in its extensive areas of "pine ridge" which are contrasted with the "cohune ridge" in the common observation of the mahogany cutters. It is notable that pine ridge descends to low altitudes. An analysis of the ecological correlations of the amphibians and reptiles with these two botanical formations remains to be made. The fact that *Sceloporus lundelli lundelli* and *S. teapensis* are apparently confined to the pine ridge association indicates that such a study, with the repetition of Stuart's Peten observations on habitat preference under the somewhat different conditions in British Honduras, affords field problems for the future. Additional collections are wanted, especially from the northern and southern districts of British Honduras. The writer is still of the opinion, expressed in the "Naturalist's Guide to the Americas," that British Honduras affords American zoologists exceptional opportunities for research in a rich tropical area.

The agreement of the number of species and subspecies of reptiles and amphibians known from British Honduras, totaling 98, with nearly the same number (96) known from the Guatemalan province of Peten, is fortuitous. No less than 31 forms in the Peten list are unrecorded from British Honduras, with about the same number known from British Honduras and not from Peten. While all (or at least most) of these Peten forms are to be expected in British Honduras with further exploration, the reciprocal is not true, since there are a few coastal forms in British Honduras which do not extend inland. These are especially *Crocodylus acutus, Aristelliger georgeensis, Anolis sagrei,* and *Anolis allisoni*. The total herpetological fauna of British Honduras will thus certainly exceed 125

forms. The species recorded from Peten but not yet from British Honduras are:

Oedipus yucatanus
Rhinophrynus dorsalis
Leptodactylus labialis
Centrolene fleischmanni
Hyla underwoodi
Hyla venulosa
Hylella picta
Triprion petasatus
Hypopachus inguinalis
Microhyla elegans
Thecadactylus rapicaudus
Anolis pentaprion
Sceloporus serrifer plioporus
Gerrhonotus moreletii
Gerrhonotus auritus
Cnemidophorus d. cozumelus
Cnemidophorus gularis
Storeria dekayi
Dendrophidion dendrophis
Coluber ortenburgeri
Coluber mentovarius
Ficimia olivacea
Tropidodipsas sartorii
Conophis lineatus
Coniophanes schmidti
Hydrocalamus quinquevittatus
Tantilla moesta
Sibon sibon
Clelia petola
Crotalus durissus durissus
Staurotypus salvini

The faunal importance of British Honduras as an independent geographic area is slight, but a knowledge of its fauna is essential to the larger problem offered by that of the Yucatan Peninsula as a whole and to the delimitation of the endemic fauna of its northern part.

The active work in progress on the Mexican herpetological fauna, especially by Hobart M. Smith, and the Guatemalan studies of L. C. Stuart, especially on the Alta Verapaz region, will affect both nomenclatorial and zoological problems in the corresponding fauna of British Honduras, a further reason for regarding the present list as provisional.

Fourteen species and subspecies, exclusive of the doubtful caecilian, *Dermophis syntremus* Cope, have been described from British Honduras, with three additions in the present paper. These are:

Eleutherodactylus sandersoni sp. nov.
Eleutherodactylus stantoni sp. nov.
Kinosternon acutum Gray
Coleonyx elegans Gray
Anolis ustus Cope
Aristelliger georgeensis Bocourt
Sceloporus lundelli lundelli Smith
Thamnophis praeocularis Bocourt
Tretanorhinus lateralis Bocourt
Pseustes poecilonotus poecilonotus Günther
Pliocercus elapoides semicinctus subsp. nov.
Elaphe triaspis Cope
Coniophanes bipunctatus Günther
Leptodeira annulata polysticta Günther
Tantilla brevis Günther
Micrurus affinis alienus Werner
Micrurus stantoni Schmidt

Of these forms *Tretanorhinus lateralis* is regarded as a synonym of *T. nigroluteus* Cope, and my own *Micrurus stantoni* is referred to *M. affinis alienus*. None of the remaining twelve valid forms can be thought of as confined to British Honduras; with the exception of the coastal *Aristelliger georgeensis* and *Anolis allisoni* they are

either already known from Peten or may be expected there and in Quintana Roo.

The forms in the following list not known from Peten number 34, but with the exception of *Crocodylus acutus*, *Aristelliger georgeensis*, *Anolis sagrei*, *Anolis allisoni*, and perhaps *Tretanorhinus nigroluteus*, they are unquestionably to be expected with further collecting. The extent of the overlap of the fauna of British Honduras with that of the Caribbean lowland of Guatemala remains to be determined.

CAUDATA

Oedipus mexicanus Duméril and Bibron

Bolitoglossa mexicana Duméril and Bibron, Erpét. Gén., 9, p. 93; atlas, pl. 104, fig. 1, 1854—Dolores, Peten (restr.).

Oedipus mexicanus Schmidt, Field Mus. Nat. Hist., Zool. Ser., **20**, p. 146, 1936.

Benque Viejo, 1 (USNM 65131, A. Versanel); Manatee, 2 (3237–8, B. H. Bailey); Middlesex, 3 (4268–70, K. P. Schmidt and L. L. Walters); Silk Grass, 2 (ITS 451, 463, I. T. Sanderson); Stann Creek Valley, 1 (ITS 511, I. T. Sanderson).

The three specimens from Middlesex were found under boards and pieces of wood. The reasons for distinguishing the Peten and British Honduran form as *mexicanus* are set forth in my paper on the Guatemalan species of *Oedipus*, cited above.

Oedipus elongatus Schmidt

Oedipus elongatus Schmidt, Field Mus. Nat. Hist., Zool. Ser., **20**, p. 165, 1936—Escobas, near Puerto Barrios, Guatemala.

Bokowina, 3 (ITS 451, 463, 511, I. T. Sanderson); Double Falls, 3 (ITS 505, I. T. Sanderson).

SALIENTIA

Bufo marinus Linnaeus

Rana marina Linnaeus, Syst. Nat., p. 211, 1758—America, restricted to Surinam.

Bufo marinus Schneider, Hist. Amph., fasc. 1, p. 219, 1799.

All Pines, 1 (CM 9875, E. R. Blake and C. T. Agostini); Belize, 32 (USNM 5799, W. A. Stanton; 4286–4302, 4307–16, 4536–37, K. P. Schmidt and L. L. Walters; ITS 399, I. T. Sanderson); El Cayo, 1 (MZUM 70400, Adolph Murie); Kate's Lagoon, 5 (ITS 520–21, 543, 345–46, I. T. Sanderson); Middlesex, 4 (4303–06, K. P. Schmidt and L. L. Walters).

Bufo marinus was breeding at Middlesex during the period of our stay (February 2–16, 1923); its long chains of eggs were frequently seen in shallow water at the edges of Stann Creek. At Belize it was

abundant at a pig pen, on the road west of the city, under troughs and boards. The association with domestic animals and with human habitations appears to be characteristic throughout its range, and accounts to a considerable extent for the great abundance of the species. Of all toads, it appears to be the species most frequently infested with ticks.

I have retained the binomial, for I know of no indication of intergradation with *Bufo paracnemis* which characterizes the Brazilian savanna region from northeastern Brazil to Paraguay, nor of intergradation of the latter form with the east Brazilian *ictericus*.

I find no distinction between Central American specimens and specimens from British Guiana. The type locality of *marinus* may be restricted to Surinam.

Bufo valliceps Wiegmann

Bufo valliceps Wiegmann, Isis, **1833**, p. 657, 1833—Mexico.

Belize, 40 (4317–41, K. P. Schmidt and L. L. Walters; ITS 400–06, 409–14, I. T. Sanderson; USNM 26067, 59938); Bokowina, 5 (ITS 417, 422, 435, 455, 460, I. T. Sanderson); Cockscomb Mountains, northern slope, 1 (CM 9874, E. R. Blake and C. T. Agostini); Cohune Ridge, 4 (MZUM 80733, C. L. Lundell); Double Falls, 2 (ITS 475–76, I. T. Sanderson); El Cayo, 3 (USNM 71278, 75119, Harry Malleis; MZUM 70393, Josselyn Van Tyne); Freetown, 2 (CM 9876–77, E. R. Blake and C. T. Agostini); Kate's Lagoon, 11 (ITS 519, 522–27, 544, 548–50, I. T. Sanderson); Manatee, 14 (3019, B. H. Bailey); Maskalls, 1 (ITS 408, I. T. Sanderson); Middlesex, 11 (4343–53, K. P. Schmidt and L. L. Walters); San Agustin, 2 (MZUM 80734, C. L. Lundell); Silk Grass, 1 (ITS 464, I. T. Sanderson).

Leptodactylus melanonotus Hallowell

Cystignathus melanonotus Hallowell, Proc. Acad. Nat. Sci. Phila., **1860**, p. 485, 1860—Nicaragua.

Leptodactylus melanonotus Brocchi, Miss. Sci. Mex., Zool., pt. 3, sec. 2, livr. 1, p. 20, 1881.

Belize, 18 (4389–4405, K. P. Schmidt and L. L. Walters; USNM 57763, W. A. Stanton); Kate's Lagoon, 16 (ITS 528–39, 542, 547, 551–52, I. T. Sanderson); Manatee, 2 (4262–63, B. H. Bailey); Silk Grass, 1 (ITS 459, I. T. Sanderson).

Eleutherodactylus ranoides Cope

Lithodytes ranoides Cope, Proc. Amer. Phil. Soc., **23**, p. 275, 1886—Nicaragua.

Eleutherodactylus ranoides Noble, Bull. Amer. Mus. Nat. Hist., **38**, p. 327, 1918.

Bokowina, 21 (ITS 418–20, 427, 430–36, 438, 440, 445, 448–50, 452–53, 456–58, I. T. Sanderson); Cockscomb Mountains, northern slope, 1 (CM 9873, E. R. Blake and C. T. Agostini); Double Falls, 16 (ITS 466–68, 471–72, 477–81, 490–91, 496–98, 509, I. T. Sanderson); Middlesex, 1 (4407, K. P. Schmidt); Silk Grass, 1 (ITS 461, I. T. Sanderson).

Eleutherodactylus rhodopis Cope

Lithodytes rhodopis Cope, Proc. Acad. Nat. Sci. Phila., 1866, p. 323, 1866—Orizaba and Cordova, Vera Cruz.

Eleutherodactylus rhodopis Noble, Bull. Amer. Mus. Nat. Hist., 38, p. 327, 1918.

Bokowina, 4 (ITS 421, 429, 442, 447, I. T. Sanderson); Cockscomb Mountains, northern slope, 1 (CM 9872, E. R. Blake and C. T. Agostini); Double Falls, 8 (ITS 469–70, 473–74, 482–83, 507–08, I. T. Sanderson); Silk Grass, 2 (ITS 462, 465, I. T. Sanderson).

Eleutherodactylus stantoni sp. nov.

Type from Valentin, British Honduras. No. 80673 Museum of Zoology, University of Michigan. Collected July 6, 1936, by C. L. Lundell.

Diagnosis.—Limbs long; head elongate, with well-defined canthus rostralis; belly smooth, with distinct fold delimiting a ventral disk; back nearly smooth, with dorsolateral glandular ridges; toes with a vestige of web at base; disks of fingers small, about equal to those of toes; vomerine teeth in rounded groups within and behind the choanae; cheeks black; posterior face of thighs without distinctive markings. Perhaps most nearly allied to *Eleutherodactylus nubilus* of Costa Rica.

Description of type.—Head a little wider than body, as wide as its length from snout to posterior border of tympanum; nostrils near the tip of the snout, which has a well-defined canthus rostralis; loreal region sloping, slightly concave, eye a little less than its distance from the nostril; tympanum large, vertically oval, nearly equal to the eye, its diameter greater than its distance from the eye; heels strongly overlapping when the limbs are placed at right angles to the body, and reaching well beyond the snout when the leg is extended along the body; disks of fingers and toes small, nearly equal; first finger distinctly longer than the second; inner metatarsal tubercle elongate, outer small but distinct; skin of back and upper surface of thighs and tibiae finely and uniformly rugose, top of head smooth; a sharp fold over the tympanum, continued along the sides of the body as a well-defined narrow fold; skin of belly smooth, with

a well-defined ventral disk; under-surfaces of thighs finely granulate posteriorly; toes with a trace of web at base; vomerine teeth in prominent rounded patches, just behind and within the choanae; tongue slightly notched behind.

Color (in alcoholic specimen) grayish brown above, almost white beneath; cheeks black to the tympani; very small light spots on the border of the lip; forearms and angles of mouth finely spotted with brown; no characteristic marking of the concealed surfaces; limbs obscurely barred.

Measurements of type.—Length from tip of snout to anus 52 mm.; from tip of snout to posterior border of tympanum, 22; width of head 22; tibia 31.6; foot from heel 43.8; leg 98.5; and arm 30.

Notes on paratype.—The single paratype, MZUM 80672, is a little darker than the type, but otherwise in extremely close agreement with it. The measurements differ slightly: body 53 mm.; length of head 22.8; width of head 23; tibia 32; length of foot from heel 42.7; leg 97.5; and arm 33.

Remarks.—I find no species in any of the adjacent regions which corresponds with this form, and it is surprisingly absent from Stuart's Peten collection, which is rich in frogs. The species is named in commemoration of the life-long interest in natural history of Father W. A. Stanton, S.J.

Since this description was drawn up, Dr. L. C. Stuart, after examination of the types and comparison with a larger specimen of *Eleutherodactylus* collected by himself in Alta Verapaz, writes me that he believes that *stantoni* may be the long lost *Hylodes laticeps*, known only from the type collected by Morelet in Yucatan. His conclusion is based primarily on the conspicuous development of the ventral disk, which is the most significant character in the somewhat inadequate description and figure of *laticeps*. I have allowed *stantoni* to stand in the present paper because of the striking development of its dorso-lateral folds and difference in head shape. My notes on the type of *laticeps* made in Paris in 1932 are as follows: "head very large and broad; ventral disk very distinct, perfectly smooth; posterior face of thighs toward vent granulate; first finger longer than second; tympanum nearly as large as eye; nearly smooth above." This is by no means conclusive as to the *absence* of dorso-lateral folds in *laticeps*, since my attention had not been drawn to the question at issue. Broadheadedness is known to develop in old male specimens of various species of *Eleutherodactylus*, and this might account for one of the differences between *stantoni* and

laticeps. Should *laticeps* be from Yucatan proper, i.e. from the northern part of the peninsula, it is probable from the general faunal relations that it is distinct from the form of the Peten Province, the forested base of the Yucatan peninsula; but Duméril's use of "Yucatan" may have been in the sense of the peninsula as a whole. Thus the matter must be left for the accumulation of further specimens and for more critical comparison of types.

Eleutherodactylus sandersoni sp. nov.

Type from Double Falls, west of Stann Creek, British Honduras. No. 504 I. T. Sanderson Collection. Adult male. Collected December 17, 1939, by Ivan T. Sanderson.

Diagnosis.—Limbs relatively short; belly rugose at sides, without a distinct ventral disk; back finely rugose, with short converging ridges behind the eyes, without dorsolateral ridges; toes with a well-defined web at base; disks of fingers and toes moderate, subequal; vomerine teeth in short transverse rows, closely juxtaposed, well behind the choanae; posterior face of thighs finely mottled; perhaps most nearly allied to *Eleutherodactylus ranoides.*

Description of type.—Head as wide as body, its width equal to the distance from snout to posterior border of tympanum; nostrils near the tip of the snout, which has a well-defined canthus rostralis; loreal region sloping, with a shallow longitudinal groove; eye a little longer than its distance from the nostril; tympanum distinct, relatively small, vertically oval; heels meeting when legs are placed at right angles to the body, reaching just beyond eye when the leg is laid along the body; disks of fingers and toes moderate, nearly equal; first finger equal to second; inner metatarsal tubercle elongate, outer distinct, round; skin of back, top of head, and upper surface of thighs finely and uniformly rugose; a sharp fold over the tympanum; skin of under-surface smooth on chest, granulate laterally and posteriorly; no ventral disk; toes with well-defined webs at base; vomerine teeth in prominent transverse ridges, well behind the choanae and closely juxtaposed; tongue large, with a slight notch.

Color (in alcoholic specimen) dark above, lighter beneath, chin, sides, and sides of belly mottled with brown; bold dark spots on the lip visible under liquid; limbs obscurely barred; posterior surfaces of thighs dark, with fine yellowish punctulation.

Measurements of type.—Length from tip of snout to anus 67; tip of snout to posterior border of tympanum 26; width of head 26; tibia 34; foot from heel 44; leg 94; and arm 37.

Notes on paratypes.—Five specimens (Nos. 486–489, 495), all from the type locality and all collected by Ivan T. Sanderson, agree with the type in all essential characters. One of these, with the throat nearly immaculate, appears to be an adult female (No. 495). This specimen measures: length, 68; length of head, 25; width of head, 26; tibia, 33; hind foot, 98; arm, 37.

Remarks.—This form and *Eleutherodactylus stantoni* seem to represent a small endemic element in the fauna of the British Honduran highland, but this may well prove to be more widespread as zoological exploration progresses in Central America.

Hyla baudinii Duméril and Bibron

Hyla baudinii Duméril and Bibron, Erpét. Gén., 8, p. 564, 1841—Mexico.

Belize, 7 (4384–87, K. P. Schmidt and L. L. Walters; 4153, W. A. Stanton; USNM 6065, W. A. Stanton; ITS 416, I. T. Sanderson); Bokowina, 4 (ITS 423, 443, 446, 454, I. T. Sanderson); Cohune Ridge, 15 (MZUM 80738, C. L. Lundell); Double Falls, 2 (ITS 495–500, I. T. Sanderson); Kate's Lagoon, 1 (ITS 517, I. T. Sanderson); Manatee, 4 (4264–67, B. H. Bailey); San Agustin, 1 (MZUM 80739, C. L. Lundell); Valentin, 8 (MZUM 80735–37, C. L. Lundell).

This hyla was calling loudly in Belize back yards on February 19 and 20, 1923, after rains.

Hyla ebraccata Cope

Hyla ebraccata Cope, Proc. Acad. Nat. Sci. Phila., 1874, p. 69, 1874—Nicaragua.

Cohune Ridge, 10 (MZUM 80742, C. L. Lundell).

In five of the ten specimens the characteristic dark dorsal pattern is *lighter* than the ground color. The thighs are completely colorless, as are the feet and tarsal joints. The tibiae are brown, with a light crossbar at the middle, which is often incomplete. The form of the dorsal marking is variable.

Hyla loquax Gaige and Stuart

Hyla loquax Gaige and Stuart, Occ. Papers, Mus. Zool. Univ. Mich., 281, p. 1, 1934—Ixpuk Aguada, north of La Libertad, Peten, Guatemala.

San Agustin, 1 (MZUM 80740, C. L. Lundell); Stann Creek Valley, 3 (ITS 513–515, Ivan T. Sanderson).

Hyla staufferi Cope

Hyla staufferi Cope, Proc. Acad. Nat. Sci. Phila., 1865, p. 195, 1865—Orizaba.

Belize, 1 (4406, K. P. Schmidt and L. L. Walters); Kate's Lagoon, 1 (ITS 516, I. T. Sanderson); San Agustin, 8 (MZUM 80741, C. L. Lundell).

Our specimen was collected on the wall of the Old Cemetery, February 23, 1923.

Agalychnis callidryas Cope

Hyla callidryas Cope, Proc. Acad. Nat. Sci. Phila., **1862**, p. 359, 1862—Panama.

Agalychnis callidryas Cope, Nat. Hist. Rev., **1865**, p. 110, 1865.

Valentin, 6 (MZUM 80743, C. L. Lundell).

Agalychnis moreletii Duméril

Hyla moreletii Duméril, Ann. Sci. Nat., (3), **19**, p. 169, 1863—Vera Paz.

Agalychnis moreletii Cope, Jour. Acad. Nat. Sci. Phila., (2), 8, p. 107, 1875.

Valentin, 15 (MZUM 80744–46, C. L. Lundell).

Rana pipiens berlandieri Baird

Rana berlandieri Baird, U. S.-Mex Bound. Surv., **2**, pt. 2, Rept., p. 27, pl. 36, figs. 7–10, 1859—southern Texas.

Belize, 13 (4410–4421, 4423, K. P. Schmidt and L. L. Walters; ITS 398, I. T. Sanderson); Big Pine Ridge, 12 miles south of El Cayo, 5 (MZUM 70406–10, Adolph Murie and Josselyn Van Tyne); El Cayo, 1 (USNM 71330, Harry Malleis); Middlesex, 2 (4422, 4424, K. P. Schmidt and L. L. Walters); San Agustin, 2 (MZUM 80730, C. L. Lundell); Stann Creek Valley, 1 (ITS 512, I. T. Sanderson); Twelve Mile Station, Stann Creek Railroad, 1 (4425, K. P. Schmidt and L. L. Walters); Valentin, 3 (MZUM 80728–29, C. L. Lundell).

Rana palmipes Spix

Rana palmipes Spix, Spec. Nov. Testud. Ranar. Brasil., p. 29, pl. 5, fig. 1, 1824—Amazon River.

Belize, 2 (4408–09, K. P. Schmidt and L. L. Walters); Bokowina, 4 (ITS 424, 437, 441, 444, I. T. Sanderson); Big Pine Ridge, 2 (MZUM 70404–5, Adolph Murie and Josselyn Van Tyne); Double Falls, 10 (ITS 484–85, 492–94, 501–03, 506, 510, I. T. Sanderson); Freetown, 8 (CM 9878–85, E. R. Blake and C. T. Agostini); Kate's Lagoon, 2 (ITS 540–41, I. T. Sanderson); Manatee, 2 (6286–87, B. H. Bailey); San Agustin, 1 (MZUM 80732, C. L. Lundell).

TESTUDINATA

Dermatemys mawii Gray

Dermatemys mawii Gray, Ann. Mag. Nat. Hist., (1), **20**, p. 60, 1847—"South America."

British Honduras, 5 (4161–63, 4166, 4176, W. A. Stanton).

Staurotypus triporcatus Wiegmann

Terrapene triporcata Wiegmann, Isis, 1828, p. 364, 1828—Rio Alvarado, Mexico.

Staurotypus triporcatus Wagler, Syst. Amph., pl. 5, figs. 44–45, 1830.

British Honduras, 1 (4164, W. A. Stanton).

Claudius angustatus Cope

Claudius angustatus Cope, Proc. Acad. Nat. Sci. Phila., 1865, p. 187, 1865—Tabasco.

British Honduras, 1 (4165, W. A. Stanton).

Kinosternon acutum Gray

Kinosternon scorpioides α acuta Gray, Syn. Rept., p. 34, pl. 7, fig. 1, 1831.

Kinosternon acutum Stejneger, Proc. U. S. Nat. Mus., 90, p. 458, 1941.

The type of this species, which has long been known under the name *berendtianum* Cope, is thought by Stejneger to be from "Honduras," and this could only mean British Honduras, as the species is otherwise known from Vera Cruz, Tabasco, and Peten. Curiously enough, there appears to be no other record from British Honduras.

Kinosternon cruentatum cruentatum Duméril

Cinosternum cruentatum Duméril, Cat. Méth. Rept., p. 16, 1851—North America.

Belize, 3 (4426–27, K. P. Schmidt and L. L. Walters; ITS 686, I. T. Sanderson); British Honduras, 2 (4167–68, W. A. Stanton).

Kinosternon leucostomum Duméril

Cinosternum leucostomum Duméril, Cat. Méth. Rept., p. 17, 1851—New Orleans; Mexico; Rio Sumasinta; Madalena Valley and Bogota, Colombia. Restr. to Rio Usumacinta, Peten, Guatemala.

Belize, 1 (ITS 685, I. T. Sanderson); Big Pine Ridge, 3 (MZUM 70462–64, Adolph Murie); Bokowina, 2 (735–36, I. T. Sanderson); Cohune Ridge, 1 (MZUM 80704, C. L. Lundell); San Agustin, 4 (MZUM 80705–08, C. L. Lundell); Valentin, 4 (MZUM 80727, C. L. Lundell).

Pseudemys ornata Gray

Emys ornata Gray, Syn. Rept., p. 30, 1831—Mazatlan.

Pseudemys ornata Cope, Jour. Acad. Nat. Sci. Phila., (2), 8, p. 153, 1875.

Belize, 5 (4428, K. P. Schmidt and L. L. Walters; USNM 51878, 56604–05, W. A. Stanton; ITS 684, I. T. Sanderson); Kate's Lagoon, 3 (ITS 904–06, I. T. Sanderson); Middlesex, 1 (4429, K. P. Schmidt and L. L. Walters); British Honduras, 3 (4173–75, W. A. Stanton).

Geoemyda areolata Duméril

Emys areolata Duméril, Cat. Méth. Rept., p. 10, 1851—Peten.

Geoemyda areolata Stuart, Misc. Publ., Mus. Zool. Univ. Mich., **29**, p. 56, 1935.

Belize, 1 (ITS 860, I. T. Sanderson); Big Pine Ridge, 1 (MZUM 70460, Adolph Murie); Silk Grass, 2 (ITS 756, 779, I. T. Sanderson).

CROCODILIA

Crocodylus acutus Cuvier

Crocodilus acutus Cuvier, Ann. Mus. Hist. Nat. Paris, **10**, p. 55, pl. 1, fig. 3, pl. 2, 1807—San Domingo.

Belize, 1 (USNM 59935, H. J. Huwe); British Honduras, 2 (4156–57, W. A. Stanton).

Crocodylus moreletii Duméril

Crocodilus moreletii Duméril, Cat. Méth. Rept., p. 28, 1851—Lake Flores (=Lake Peten).

Crocodylus moreletii Schmidt, Field Mus. Nat. Hist., Zool. Ser., **12**, p. 79, pl. 5, 1924.

Belize, 10 (4430–38, K. P. Schmidt and L. L. Walters; USNM 10288); Cocquericot, 1 (MZUM 75032, L. C. Stuart).

SAURIA

Coleonyx elegans Gray

Coleonyx elegans Gray, Ann. Mag. Nat. Hist., (1), **16**, p. 162, 1845—Belize.

Belize, 2 (BMa, type, Dyson; 4178, W. A. Stanton); Benque Viejo, 1 (USNM 65132, A. Versanel); Kate's Lagoon, 1 (ITS 882, I. T. Sanderson); Silk Grass, 1 (ITS 757, I. T. Sanderson); Stann Creek Valley, 1 (ITS 850, I. T. Sanderson).

Sphaerodactylus glaucus Cope

Sphaerodactylus glaucus Cope, Proc. Acad. Nat. Sci. Phila., **1865**, p. 192, 1865—Merida, Yucatan.

Manatee, 2 (4261, 5827, B. H. Bailey); Silk Grass, 1 (ITS 758, I. T. Sanderson); Stann Creek, 3 (BM 1890.10.24.3, 1891.3.4.1, and 1893.3.4.3, J. Robertson); British Honduras, 1 (4127, W. A. Stanton).

Sphaerodactylus lineolatus Lichtenstein

Sphaeriodactylus lineolatus Lichtenstein, Nomen. Rept. Amph. Mus. Berol., p. 6, 1856—Veragoa (=Veragua), Panama.

All Pines, 1 (CM 8493, E. R. Blake and C. T. Agostini); Belize, 1 (USNM 31338, Mrs. Meehling); Cockscomb Mountains, eastern slope, 1 (CM 8484, E. R. Blake and C. T. Agostini).

Phyllodactylus lanei Smith

Phyllodactylus lanei Smith, Univ. Kans. Sci. Bull., 22, p. 125, pl. 25, fig. 3, text fig. 1B, 1935.

Belize, 2 (4449–50, K. P. Schmidt and L. L. Walters); Half Moon Cay, 7 (34030–36, D. D. Davis); North River, 1 (USNM 52310, W. A. Stanton); British Honduras, 2 (USNM 58957–58, W. A. Stanton).

Smith has set forth the case for recording this widespread species as *lanei* instead of under the familiar name *tuberculosus*. His conclusion is followed here pending the much needed revision of the genus. Our Belize specimens were collected on the walls of the Old Cemetery.

Aristelliger georgeensis Bocourt

Idiodactylus georgeensis Bocourt, Miss. Sci. Mex., Zool., pt. 3, sec. 1, livr. 2, p. 41, pl. 10, fig. 1, 1873—Saint George Cay, near Belize.

Manatee, 4 (5628–31, B. H. Bailey); Tom Owen Cay, 2 (4451–52, K. P. Schmidt and L. L. Walters).

This species has long been regarded as identical with *Aristelliger praesignis* of Jamaica. The number of subdigital lamellae in the British Honduran specimens is 14 on the fifth and 14 to 16 on the fourth digit, while in the three specimens available from Jamaica the figures are 10–12 and 13–14 respectively. Further study is required to establish the degree of distinctness of the two forms, but it appears useful to call attention to this problem by the use of Bocourt's name. In any case this gecko evidently belongs to the limited coastal and cay fauna with West Indian affinities represented also by *Anolis sagrei* and *Anolis allisoni*.

Specimens obtained on Tom Owen Cay were obtained for us by the captain of the schooner *Aurora* from the trunks of coco palms by throwing pieces of coral at them; they had apparently been in hiding under the trash on the ground. The limited land fauna of the cays affords an opportunity for an interesting ecological study of mode of dispersal, population numbers, and other environmental relations, simplified by the fewness of the species present.

Anolis aureolus Cope

Anolis aureolus Cope, Proc. Amer. Phil. Soc., 22, p. 390, 1885—Yucatan and Guatemala.

Belize (North River), 1 (USNM 58694, W. A. Stanton); Baking Pot, 1 (MCZ 18954, H. O. Rickettson); Valentin, 2 (MZUM 80688, C. L. Lundell).

Anolis beckeri Boulenger

Anolis beckeri Boulenger, Proc. Zool. Soc. Lond., 1881, p. 921, 1881—Yucatan.

Belize, 1 (4483, K. P. Schmidt and L. L. Walters).

Anolis biporcatus Wiegmann

Dactyloa biporcata Wiegmann, Herp. Mex., p. 47, 1834—Mexico.

Anolis biporcatus Bocourt, Miss. Sci. Mex., Zool., pt. 3, sec. 1, livr. 2, p. 98 [excl. of text and pl.], 1873.

Bokowina, 7 (ITS 702–03, 717, 723, 743–44, 747, I. T. Sanderson); Cohune Ridge, 1 (MZUM 80681, C. L. Lundell); Double Falls, 2 (ITS 802, 820, I. T. Sanderson); San Agustin, 1 (MZUM 80682, C. L. Lundell); Silk Grass, 1 (ITS 788, I. T. Sanderson); Valentin, 1 (MZUM 80683, C. L. Lundell).

Dr. L. C. Stuart convinces me (in litt.) that Wiegmann's name *biporcatus* applies to what has become known as *Anolis copei* Bocourt, and that the *Anolis biporcatus* of authors must take the name *bourgaei* Bocourt. Briefly, he finds that the type of *biporcatus* much exceeds in size any known specimen of the form that has become known under that name, and that in the proportionate length of its limbs it corresponds well with *copei* and not at all with *biporcatus* auct., which has longer limbs. This matter will be set forth in more detail by Dr. Stuart.

Anolis bourgaei Bocourt

Anolis bourgaei Bocourt, Miss. Sci. Mex., Zool., pt. 3, sec. 1, livr. 2, p. 76, pl. 15, fig. 9, 1873—Huatusco and Orizaba, Vera Cruz.

Belize (North River), 2 (USNM 58171, 58173, W. A. Stanton); Bokowina, 6 (ITS 720, 724, 738, 746, 749, 751, I. T. Sanderson); Cocquericot, 7 (MZUM, L. C. Stuart); Freetown, 1 (CM 8595, E. R. Blake and C. T. Agostini); Grant's Works, 1 (ITS 825, I. T. Sanderson); Kate's Lagoon, 9 (ITS 862–67, 878–79, 896, I. T. Sanderson); Manatee, 1 (4260, B. H. Bailey); Middlesex, 3 (4479–81, K. P. Schmidt and L. L. Walters); Silk Grass, 18 (ITS 753–55, 760–61, 764–66, 773, 776, 782–86, 789, 791, 797, I. T. Sanderson); Stann Creek Valley, 1 (ITS 855, I. T. Sanderson).

Anolis capito Peters

Anolis (Draconura) capito Peters, Monatsber. Akad. Wiss. Berlin, 1863, p. 142, 1863—Costa Rica.

Bokowina, 2 (ITS 704, 748, I. T. Sanderson); Manatee, 1 (MCZ 19320, W. A. Stanton); Silk Grass, 2 (ITS 780–81, I. T. Sanderson); Valentin, 7 (MZUM 80683–87, C. L. Lundell).

Two specimens exhibit the extraordinary lineate pattern, which seems to be an alternative one in this species; both are females, but other female specimens have the normal pattern of irregular dark crossbands.

Anolis ruthveni Stuart

Anolis ruthveni Stuart, Occ. Papers, Mus. Zool. Univ. Mich., **310**, p. 1, 1935—Santa Teresa, Peten, Guatemala.

Bokowina, 11 (ITS 699, 705–06, 710–14, 718–19, 728, I. T. Sanderson); Cockscomb Mountains, east slope, 1 (CM 8483, E. R. Blake and C. T. Agostini); Cockscomb Mountains, northern slope, 1 (CM 8486, E. R. Blake and C. T. Agostini); Dog Creek, 3 (ITS 770–72, I. T. Sanderson); Double Falls, 7 (ITS 799, 804, 806, 810, 814–16, I. T. Sanderson); Silk Grass, 12 (ITS 692–98, 777–79, 792–93, I. T. Sanderson); Sixteen Mile Station, inland from Stann Creek, 4 (4484–87, K. P. Schmidt and L. L. Walters); Valentin, 25 (MZUM 80689–92, C. L. Lundell).

Anolis sagrei Duméril and Bibron

Anolis sagrei Duméril and Bibron, Erpét. Gén., **4**, p. 149, 1837—Cuba.

Belize, 150 (4464–68, K. P. Schmidt and L. L. Walters; ITS 601–27, 629–46, I. T. Sanderson; USNM 25104–05, 26070, 26072–73, 58290–92); Glover's Reef, 199 (CM 8518–8644, E. R. Blake and C. T. Agostini; 34602–11, 34617–18, D. D. Davis); Half Moon Cay, 1 (34653, D. D. Davis); Manatee, 5 (MCZ 19315–19, W. A. Stanton); Tom Owen Cay, 12 (4478, K. P. Schmidt and L. L. Walters); Turneffe Islands, 19 (34625–26, D. D. Davis); British Honduras, 7 (4179–85, W. A. Stanton).

There appear to be slight differences between specimens from British Honduras and those from Cuba and Jamaica, such as the more frequent contact of the semicircles in the former, but these differences do not appear to warrant taxonomic distinction. I interpret the range as due to some exceptional means of dispersal, which associates this form with the geckos of the genus *Aristelliger*.

The Caracas record for this species (Boulenger, 1885, p. 41) may rest on an exchange of unnumbered specimens, since a specimen of *Anolis chrysolepis* is recorded by him from "Honduras."

Anolis sericeus Hallowell

Anolis sericeus Hallowell, Proc. Acad. Nat. Sci. Phila., **1856**, p. 227, 1856—Jalapa, Mexico.

Belize, 1 (USNM 65125); Belize (North River), 1 (USNM 58172, W. A. Stanton).

Anolis tropidonotus Peters

Anolis tropidonotus Peters, Monatsber. Akad. Wiss. Berlin, **1863**, p. 135, 1863—Huanuco, Mexico.

Cohune Ridge, 1 (MZUM 80693, C. L. Lundell); El Cayo, 1 (USNM 75118, Harry Malleis); Manatee, 1 (4259, B. H. Bailey).

Anolis ustus Cope

Anolis ustus Cope, Proc. Acad. Nat. Sci. Phila., **1864**, p. 172, 1864—Belize.

Belize, 2 (BM a, b); Belize (North River), 3 (USNM 58476–78, W. A. Stanton).

The trinomial form is dropped on the basis of Stuart's opinion (in litt.) that the type of *Anolis ustus veraepacis* Barbour is referable to *Anolis bourgaei* Bocourt.

Anolis allisoni Barbour

Anolis allisoni Barbour, Proc. New Engl. Zool. Club, **10**, p. 58, 1928—Coxen Hole, Ruatan Island, Honduras.

Half Moon Cay, 13 (CM 4156–57, E. G. Holt; 34628–29, D. D. Davis).

The presence of this remarkably distinct representative of the Cuban *porcatus* group on Half Moon Cay contributes to our knowledge of its distribution. *A. allisoni* does not seem to occur on the Central American mainland.

Basiliscus vittatus Wiegmann

Basiliscus vittatus Wiegmann, Isis, **1828**, p. 373, 1828—Mexico.

All Pines, 3 (CM 8491–92, 8494, E. R. Blake and C. T. Agostini); Belize, 71 (4496–4529, K. P. Schmidt and L. L. Walters; ITS 592–97, 651–54, 666–67, 670–71, 676, 680–81, 687, I. T. Sanderson; USNM 24914–15, 26358, 51885–86, 56788–801); Big Pine Ridge, 1 (MZUM 70425, Adolph Murie); Bokowina, 4 (ITS 742–45, I. T. Sanderson); Double Falls, 1 (ITS 800, I. T. Sanderson); El Cayo, 1 (USNM 71374, Harry Malleis); Freetown, 13 (CM 8497–8500, 8502–10, E. R. Blake and C. T. Agostini); Grant's Works, 1 (ITS 822, I. T. Sanderson); Kate's Lagoon, 6 (ITS 868–69, 871, 880, 886, 902, I. T. Sanderson); Manatee, 8 (5824, 6769–71, B. H. Bailey); Middlesex, 2 (4530–31, K. P. Schmidt and L. L. Walters); San Agustin, 5 (MZUM 80679, C. L. Lundell); Silk Grass, 1 (ITS 787, I. T. Sanderson); Stann Creek, 19 (4532–35, K. P. Schmidt and L. L. Walters; ITS 827–35, 838–43, I. T. Sanderson); British Honduras, 2 (4186, USNM 26066, W. A. Stanton).

Laemanctus deborrei Boulenger

Laemanctus deborrei Boulenger, Bull. Soc. Zool. France, 1877, p. 460, 1877—Tabasco.

Middlesex, 1 (4488, K. P. Schmidt).

Corythophanes cristatus Merrem

Agama cristata Merrem, Tent. Syst. Amph., p. 50, 1820—Ceylon (in errore).

Corythophanes cristatus Gray, Griffith's Animal Kingdom, 9, (Synopsis), p. 55, 1831.

Cohune Ridge, 1 (MZUM 80678, C. L. Lundell); Manatee, 1 (5826, B. H. Bailey); Silk Grass, 2 (ITS 796, 809, I. T. Sanderson).

Corythophanes hernandesii Wiegmann

Chamaeleopsis hernandesii Wiegmann, Isis, p. 298, 1831—tropical Mexico.

Corythophanes hernandesii Boulenger, Cat. Liz. Brit. Mus., 2, p. 103, 1885.

Silk Grass, 2 (ITS 752, 767, I. T. Sanderson).

Iguana iguana rhinolopha Wiegmann

Iguana rhinolopha Wiegmann, Herp. Mex., p. 44, 1834—Mexico.

Iguana iguana rhinolopha Van Denburgh, Proc. Acad. Nat. Sci. Phila., 1897, p. 461, 1897.

Belize, 1 (4489, K. P. Schmidt and L. L. Walters); Half Moon Cay, 2 (CM 7658, E. G. Holt; 34624, D. D. Davis).

Ctenosaura similis Gray

Iguana (Ctenosaura) similis Gray, Griffith's Animal Kingdom, 9, (Synopsis), p. 38, 1831—no locality.

Belize, 15 (4490–93, K. P. Schmidt and L. L. Walters; ITS 598, 647, 655–57, 672–75, I. T. Sanderson; BM no No.); Freetown, 1 (CM 8513, E. R. Blake and C. T. Agostini); Glover's Reef, 11 (CM 8517, E. R. Blake and C. T. Agostini; MCZ 22088, L. L. Mowbray; 34612–16, 34619–22, D. D. Davis); Half Moon Cay, 3 (CM 4154–55, E. G. Holt; 34623, D. D. Davis); Stann Creek, 2 (4495–96, K. P. Schmidt and L. L. Walters); British Honduras, 1 (4187, W. A. Stanton).

It is surprising to find this heavy-bodied species a regular inhabitant of the offshore cays. It is known in British Honduras under the singular common name of "wish-willy."

Sceloporus chrysostictus Cope

Sceloporus chrysostictus Cope, Proc. Acad. Nat. Sci. Phila., 1866, p. 125, 1866—Yucatan.

Belize (North River), 1 (USNM 57005, W. A. Stanton); Kate's Lagoon, 7 (ITS 882, 892–95, 899–900, I. T. Sanderson).

Sceloporus teapensis Günther

Sceloporus teapensis Günther, Biol. Centr.-Amer., Zool., Rept. Batr., fasc. 10, p. 75, 1890—Teapa, Tabasco.

Big Pine Ridge, 3 (MZUM 70423–24, Josselyn Van Tyne and Adolph Murie); San Agustin, 16 (MZUM 80676–77, C. L. Lundell).

Sceloporus lundelli lundelli Smith

Sceloporus lundelli lundelli Smith, Field Mus. Nat. Hist., Zool. Ser., 26, p. 66, fig. 8, pl. 4, 1939—Cohune Ridge, British Honduras.

Belize River at El Cayo, 1 (MZUM 80675, paratype, C. L. Lundell); Cohune Ridge, 1 (MZUM 80674, type, C. L. Lundell).

Lepidophyma flavimaculatum Duméril

Lepidophyma flavimaculatum Duméril, Cat. Méth. Rept., p. 137, 1851—Peten.

Baking Pot, 2 (MCZ 18952–53, H. O. Rickettson); Bokowina, 10 (ITS 707–09, 715, 726, 730–31, 733, 741, 750, I. T. Sanderson); Double Falls, 2 (ITS 798, 808, I. T. Sanderson); Middlesex, 1 (4455, K. P. Schmidt and L. L. Walters); Twelve-mile Station (Stann Creek Railroad), 2 (4453–54, K. P. Schmidt and L. L. Walters).

Celestus steindachneri Cope

Diploglossus steindachneri Cope, Proc. Acad. Nat. Sci. Phila., 1864, p. 179, 1864—Orizaba, Mexico.

Celestus steindachneri Cope, idem, 1868, p. 123, 1868.

Bokowina, 1 (ITS 734, I. T. Sanderson).

Ameiva undulata Wiegmann

Cnemidophorus undulatus Wiegmann, Herp. Mex., p. 27, 1934—Mexico.

Ameiva undulata Gray, Cat. Liz. Brit. Mus., p. 20, 1845.

Belize, 20 (4461–63, K. P. Schmidt and L. L. Walters; 4188–89, W. A. Stanton; USNM 26069, 51879–80, 59936, W. A. Stanton and H. J. Huwe; ITS 599–600, 658–64, 678–79, I. T. Sanderson); El Cayo, 2 (USNM 71372–73, Harry Malleis); Kate's Lagoon, 5 (ITS 670, 672–75, I. T. Sanderson); Manatee, 3 (6766–68, B. H. Bailey); Maskalls, 1 (ITS 650, I. T. Sanderson); Stann Creek Valley, 1 (ITS 836, I. T. Sanderson).

The geographic variation of this species is being studied in detail by Dr. L. C. Stuart.

Ameiva festiva Lichtenstein

Cnemidophorus festivus Lichtenstein, Nomen. Rept. Amph. Mus. Berol., p. 13, 1856—Veragoa.

Ameiva festiva Bocourt, Miss. Sci. Mex., Zool., pt. 3, livr. 4, p. 260, pl. 20, fig. 2, pl. 20A, fig. 10, pl. 20D, fig. 6, 1874.

Bokowina, 3 (ITS 700–01, 725, I. T. Sanderson); Double Falls, 1 (ITS 801, I. T. Sanderson); Middlesex, 2 (4459–60, K. P. Schmidt and L. L. Walters).

Mabuya mabouya mabouya Lacépède

Lacertus mabouya Lacépède, Hist. Nat. Quad. Ovip. Serp., 2, p. 378, pl. 24, 1788—Lesser Antilles (restr.).

Mabuya mabouya mabouya Dunn, Proc. Acad. Nat. Sci. Phila., 87, p. 544, 1936.

Belize, 17 (4457–58, K. P. Schmidt and L. L. Walters; 4190–95, W. A. Stanton; USNM 26074, 58161, 58373–78, 59936, W. A. Stanton and H. J. Huwe); Cockscomb Mountains, northern slope, 2 (CM 8487–88, E. R. Blake and C. T. Agostini); Manatee, 1 (4258y, B. H. Bailey); Silk Grass, 1 (ITS 759, I. T. Sanderson); Sixteen-mile Station, Stann Creek Railroad, 1 (4456, K. P. Schmidt and L. L. Walters); Stann Creek Valley, 4 (ITS 844, 847, 852–53, I. T. Sanderson).

Eumeces sumichrasti Cope

Plistodon sumichrasti Cope, Proc. Acad. Nat. Sci. Phila., 1866, p. 321, 1866—Orizaba [corrected to Potrero, near Cordoba].

Eumeces sumichrasti Bocourt, Miss. Sci. Mex., Zool., pt. 3, sec. 1, livr. 6. p. 422, 1879.

Cohune Ridge, 1 (MZUM 80702, C. L. Lundell); Retiro, 1 (MZUM 80701, C. L. Lundell).

Eumeces schwartzei Fischer

Eumeces schwartzei Fischer, Abh. Naturw. Ver. Hamburg, 8, Abt. 1, No. 3, p. 3, pl. 7, fig. 1, 1884—Island in Laguna de Terminos, Campeche.

Cockscomb Mountains, eastern slope, 1 (CM 8482, E. R. Blake and C. T. Agostini).

Leiolopisma assatum Cope

Lampropholis assatus Cope, Proc. Acad. Nat. Sci. Phila., 1864, p. 179, 1864—Volcan Isalco, Guatemala.

Leiolopisma assatum Schmidt, Field Mus. Nat. Hist., Zool. Ser., 12, p. 199, 1928.

Bokowina, 3 (ITS 722, 727, 739, I. T. Sanderson); Double Falls 3 (ITS 803, 807, 817, I. T. Sanderson); Silk Grass, 2 (ITS 690–91, I. T. Sanderson).

SERPENTES

Constrictor constrictor imperator Daudin

Boa imperator Daudin, Hist. Nat. Rept., 5, p. 150, 1803—Colombian Choco.

Constrictor constrictor imperator Ruthven, Zool. Jahrb., Syst., 32, p. 323, 1912.

Belize, 3 (USNM 26063, W. A. Stanton; MZUM 74922, L. C. Stuart; ITS 561, I. T. Sanderson); Cocquericot, 1 (MZUM 74926, L. C. Stuart); El Cayo, 1 (USNM 71359, Harry Malleis); Turneffe Islands, 1 (34627, D. D. Davis); British Honduras, 1 (BM no No., C. D. Godman).

The common boa of British Honduras appears to agree in every way with specimens from adjoining faunal areas.

Sibynophis annulatus annulatus Duméril and Bibron

Enicognathus annulatus Duméril and Bibron, Erpét. Gén., 7, p. 355, pl. 80, fig. 1, 1854—Coban, Alta Verapaz, Guatemala.

Sibynophis annulatus annulatus Schmidt, Proc. Biol. Soc. Wash., **49**, p. 48, 1936.

Belize, 1 (USNM 35598); Stann Creek Valley, 1 (ITS 857, I. T. Sanderson).

The specimen from Belize is a male with 139 ventrals, 141 caudals, upper labials 9, lower labials 10, oculars 1–2, and temporals 1–2 on one side and 1–1–2 on the other; Mr. Sanderson's specimen is a female, with 156 ventrals, tail incomplete.

Ninia sebae sebae Duméril and Bibron

Streptophorus sebae Duméril and Bibron, Erpét. Gén., 7, p. 515, 1854—Mexico (restr. to Vera Cruz).

Ninia sebae sebae Schmidt and Andrews, Field Mus. Nat. Hist., Zool. Ser., **20**, p. 170, 1936.

Baking Pot, 1 (MCZ 18951, H. O. Rickettson); Belize, 10 (USNM 24909–10, 56433–34, W. A. Stanton; ITS 589–91, 665, 858, I. T. Sanderson; BM 51–10–11–36); Bokowina, 2 (ITS 729, 732, I. T. Sanderson); Grant's Works, 1 (ITS 824, I. T. Sanderson); Manatee, 16 (8483, 7008–22, B. H. Bailey); Middlesex, 2 (4439–40, K. P. Schmidt and L. L. Walters); Silk Grass, 3 (ITS 762–63, 769, I. T. Sanderson); Stann Creek, 4 (USNM 26062, W. A. Stanton; ITS 845, 849, 854, I. T. Sanderson); British Honduras, 5 (BM no No.).

This form has been distinguished by E. W. Andrews and myself from its ally in Yucatan, *Ninia sebae morleyi*, primarily on account of different ventral and caudal scale counts. The extremes and averages of ventrals and caudals in the above specimens are shown in the following table:

	Ventrals			Caudals		
Sex	No. of specimens	Extremes	Averages	No. of specimens	Extremes	Averages
Male	20	133–145	138	20	51–71	59
Female	24	137–147	142	22	42–60	50

The cross-mark for the average of caudals in British Honduran female specimens in fig. 21, in our discussion of *Ninia sebae morleyi* (Schmidt and Andrews, 1936, p. 170), is set at 57, which is obviously in error. The correction does not greatly alter the relation of the two subspecies.

Thamnophis sauritus rutiloris Cope

Eutaenia rutiloris Cope, Proc. Amer. Phil. Soc., *22*, p. 388, 1885—Cozumel Island, Yucatan.

All Pines, 1 (CM 8490, E. R. Blake and C. T. Agostini); Belize, 8 (BM no No., J. Smith; 4228–33, W. A. Stanton; 4441, K. P. Schmidt and L. L. Walters; ITS 648, I. T. Sanderson); British Honduras, 1 (USNM 26357).

Dr. Dunn calls my attention to the fact that *Prymnomiodon chalceus* Cope (1860) is based on a *Thamnophis sauritus* with the low ventral count characteristic of the Central American representatives of the species. I have provisionally retained *rutiloris* for the British Honduran snake since its type locality is near-by, and since it is clear that a more thorough-going analysis of the Central American *sauritus* is desirable.

All our specimens have the anterior upper labials immaculate, while the last two labials tend to be invaded by the dark adjacent color of the neck. This appears to exclude the possibility that Bocourt's species *praeocularis* could be referred here. It seems evident that *Thamnophis arabdotus* Andrews, of Yucatan, is either closely allied to *praeocularis* or a synonym of it. Further specimens from British Honduras are required to throw light on this problem.

The ventrals in seven male specimens range from 142 to 153, and in three female specimens from 146 to 156. Only six specimens have a complete tail, one of which is a juvenile female with 97 caudals. The caudals of five male specimens range from 85 to 101. The dorsal scales are uniformly 19 at mid-body; the upper labials are uniformly 8, and the lower 10; the preocular is single; postoculars 3, except on one side in one specimen in which they are 2; temporals uniformly 1–2. The largest specimen available measures only 500 mm., of which the tail accounts for 155 mm.

Thamnophis praeocularis Bocourt

Eutaenia praeocularis Bocourt, Le Naturaliste, **14**, p. 278, 1892—Belize.

This species is still known only from the type, unless *Thamnophis arabdotus* Andrews of Yucatan should prove referable to it, as Drs. Dunn and H. M. Smith (in litt.) suspect.

Tretanorhinus nigroluteus Cope

Tretanorhinus nigroluteus Cope, Proc. Acad. Nat. Sci. Phila., **1861**, p. 298, 1861—Greytown, Nicaragua.

Belize, 2 (USNM 26057, 56369, W. A. Stanton).

In No. 26057, a male, the ventrals number 142 and the caudals 56; in No. 56369, a female, these are respectively 138 and 60. The dorsal scale formula in the male is 21–19–17, in the female 21–19. The female specimen measures 770, tail 170.

Dryadophis melanolomus melanolomus Cope

Masticophis melanolomus Cope, Proc. Acad. Nat. Sci. Phila., **1868**, p. 105, 1868—Yucatan.

Dryadophis melanolomus melanolomus Stuart, Misc. Publ., Mus. Zool. Univ. Mich., **49**, p. 88.

San Agustin, 1 (MZUM 80714, C. L. Lundell); Silk Grass, 1 (ITS 775, I. T. Sanderson).

The single female specimen at the University of Michigan has 172 ventrals and 110 caudals; in Mr. Sanderson's male specimen they are 176 and 117. Specimens from British Honduras and Peten are regarded by Stuart as intermediate between the typical *melanolomus* of Yucatan and *Dryadophis melanolomus laevis* of Alta Verapaz.

Drymobius margaritiferus Schlegel

Herpetodryas margaritiferus Schlegel, Physion. Serp., **2**, p. 184, 1837.

Drymobius margaritiferus Cope, Proc. Acad. Nat. Sci. Phila., **1860**, p. 561, 1860.

Belize, 6 (4198–99, W. A. Stanton; USNM 24904, 24971, 26353, Parsons and Bennett; BM 1893–4–27–2); Belize, 40 miles inland, 3 (BM 1924–2–18–3, 4, 5, H. B. Newham); Manatee, 1 (3482, B. H. Bailey); Middlesex, 1 (4442, K. P. Schmidt and L. L. Walters).

In five males the ventrals range from 146 to 156, average 151, while in six females the range is from 143 to 153, average 148. Only one female has a complete tail, with 106 caudals; in four males the caudals range from 111 to 125. The largest specimen (with an incomplete tail) measures 980 mm.

Pseustes poecilonotus poecilonotus Günther

Spilotus poecilonotus Günther, Cat. Colubrine Snakes, p. 100, 1858—Honduras.

San Agustin, 1 (MZUM 80720, C. L. Lundell); Valentin, 1 (MZUM 80719, C. L. Lundell).

It may be suspected that the type of this species, in the British Museum, came from British Honduras. In the two specimens examined, both female, the ventrals are 208 and 218, and the caudals,

in the one specimen with a complete tail, 126; the dorsal scale rows at mid-body number 23.

Spilotes pullatus mexicanus Laurenti

Cerates mexicanus Laurenti, Syn. Rept., p. 83, 1768—Mexico [by implication].

Spilotes pullatus mexicanus Amaral, Mem. Inst. Butantan, 4, p. 282, 1929.

Belize, 1 (BM no No.); Cocquericot, 2 (MZUM 74906–07, L. C. Stuart); Kate's Lagoon, 1 (ITS 861, I. T. Sanderson); Stann Creek, 2 (BM 1890–10–24–4, 1891–3–4–5, J. Robertson); British Honduras, 2 (4205–06, W. A. Stanton).

Ventrals in two males are 206 and 212; in two females they are 213 and 217; the caudals in males are 127 and 132, and in the three females 125, 130, and 131. The dorsal scale rows reduce to 15 in one, to 14 in one, and to 13 in three. The temporals are 1–1 in three specimens and 2–1 in two.

Drymarchon corais melanurus Duméril and Bibron

Spilotes melanurus Duméril and Bibron, Erpét. Gén., 7, p. 224, 1854—Mexico and Central America.

Drymarchon corais melanurus Stejneger and Barbour, Check List N. A. Rept. Amph., p. 85, 1917.

Bokowina, 1 (ITS 740, I. T. Sanderson); Freetown, 3 (CM 8511, 8514–15, E. R. Blake and C. T. Agostini); Stann Creek, 1 (BM 1891–3–4–4, J. Robertson).

The five specimens examined are remarkably uniform in scale characters. The ventrals in three male specimens number 195, 195, and 199, and the caudals 73, 79, and 77; in the single female these counts are 201 and 80. One of the specimens from Freetown has two loreals on each side. The largest specimen measures 2,525 mm., of which the tail occupies 370 mm.

Elaphe triaspis Cope

Coluber triaspis Cope, Proc. Acad. Nat. Sci. Phila., 1866, p. 128, 1866—Belize.

Elaphe triaspis Amaral, Mem. Inst. Butantan, 4, p. 159, 1929.

This species, now recorded in some numbers from Yucatan, is known from British Honduras only from the type. The type specimen had dorsal scales 33, ventrals 266, caudals 118. The species is well known from Yucatan. The status of the specimens recorded from other parts of Central America is uncertain, since it appears to be unknown in Peten. The distinctions between this and the following form still require study.

Elaphe flavirufa flavirufa Cope

Coluber flavirufus Cope, Proc. Acad. Nat. Sci. Phila., 1866, p. 319, 1866—Yucatan.

Elaphe flavirufa flavirufa Smith, Copeia, 1941, p. 132, 1941.

The British Museum specimen recorded from Belize by Boulenger (1894, p. 39) is the only *flavirufa* known from British Honduras. The specimen in question is a juvenile male, with dorsal scales in 33 rows (not 31 as reported by Boulenger); ventrals 263; caudals 116.

Leptophis mexicanus Duméril and Bibron

Leptophis mexicanus Duméril and Bibron, Erpét. Gén., 7, p. 536, 1854—Mexico.

Belize, 5 (BM no No., J. Smith; USNM 24907, 26056, 56149, W. A. Stanton and Parsons; ITS 682, I. T. Sanderson); Cohune Ridge, 1 (MZUM 80709, C. L. Lundell); Manatee, 2 (3479, 5633, B. H. Bailey); Stann Creek, 2 (BM 1890–6–18–2 and 1890–10–24–7, J. Robertson); British Honduras, 1 (USNM 26356, Bennett).

The above series of specimens includes eight male specimens and three females. The ventrals in the males range from 154 to 164, averaging 159; they number 165 in two females, 162 in a third. The caudals in males range from 158 to 173, averaging 164, and number 156, 152, and 162 in the females.

Leptophis occidentalis occidentalis Günther

Ahaetulla occidentalis Günther, Proc. Zool. Soc. Lond., 1859, p. 412, 1859—Guayaquil, Ecuador.

Leptophis occidentalis occidentalis Stuart, Occ. Papers, Mus. Zool. Univ. Mich., 292, p. 15, 1934.

Cohune Ridge, 1 (MZUM 80713, C. L. Lundell); Stann Creek, 1 (BM 1892–1–4–2, J. Robertson); British Honduras, 2 (BM 1894–6–4–1, 1895–2–21–4, F. D. Godman and Colonial Exhibition).

The two males have ventrals 172 and 177, and caudals 169 and 167; in the two females these counts are 181 and 185, and 176 and 170. Upper labials in the four specimens are 9–9, 8–8, 9–8, and 9–8.

Stuart is followed in the use of the trinomial; the genus is obviously in need of revisionary study.

Xenodon rabdocephalus mexicanus Smith

Xenodon mexicanus Smith, Proc. Biol. Soc. Wash., 53, p. 57, 1940—Piedras Negras, Guatemala.

Belize, 1 (4257, B. H. Bailey); Kate's Lagoon, 2 (ITS 881, 883, I. T. Sanderson); Silk Grass, 2 (ITS 768, 790, I. T. Sanderson); British Honduras, 2 (BM 1894–4–27–1, 2).

Pliocercus elapoides semicinctus subsp. nov.

Type from Double Falls, west of Stann Creek, British Honduras. No. 805 I. T. Sanderson Collection. Adult female. Collected December 13, 1939, by Ivan T. Sanderson.

Diagnosis.—A *Pliocercus* with narrow black saddles open ventrally (instead of rings), accessory saddles reduced to merest trace, and a low number of saddles, nine on body, six to eight on tail; most directly allied to *Pliocercus elapoides laticollaris* Smith, which has rings complete, 13 to 18 on the body, and 10 to 12 on the tail.

Description of type.—Body cylindrical, head a little wider than body, somewhat depressed, tail slender. Rostral just visible from above; internasals half as long as prefrontals; frontal five-sided, the lateral sides parallel, its length equal to its distance from the end of the snout, and to the length of the parietal suture; nasal divided; loreal quadrangular; two preoculars, the lower small; two postoculars; temporals 1–1 on each side, the anterior elongate; upper labials eight, the fourth and fifth entering the eye; lower labials 10; chin shields large, subequal. Dorsal scales smooth, without pits, in 17 rows throughout; ventrals 130; anal divided; caudals 105.

Upper part of snout black, extending to the posterior edge of the supraoculars, and extending downward to the upper half of the upper labials; tip of snout light; yellow band across parietals with a forward projecting point on the tip of the frontal; a black nuchal saddle extending across the tips of the parietals, and across the first five dorsal scales behind them; seven additional black saddles on the body two to three scale-lengths in width, extending downward to the first scale row or to the tips of the ventrals, narrower ventrad, bordered on each side by a yellow band about a scale length in width; scales of the red zones between the black and yellow saddles with black tips; these black tips slightly concentrated to form a narrow accessory black crossband adjacent to the last two saddles and on the six caudal black rings (which are closed ventrad); belly without black markings, the yellow probably extending across it in life.

Length 657, tail 263.

Notes on paratype.—A male specimen in the British Museum, No. 1894-12-28-25, has dorsals 17-17-15, ventrals 124, caudals 114, head scales as in the type, and black rings 9+8. My notes do not state whether or not the "rings" are open ventrally as in the type.

Remarks.—The appearance of Hobart Smith's revision of the Mexican forms of *Pliocercus* (1941, p. 119) makes it clear that the form in British Honduras is distinguishable from *laticollaris* of

Tabasco and Campeche, and thus from *P. elapoides elapoides*, though it must be admitted that additional material of both *laticollaris* and *semicinctus* is required for a more definitive description.

Lampropeltis triangulum polyzona Cope

Lampropeltis polyzona Cope, Proc. Acad. Nat. Sci. Phila., **1860**, p. 258, 1860—Quatupe, near Jalapa, Vera Cruz.

Lampropeltis triangulum polyzona Dunn, Occ. Papers, Mus. Zool. Univ. Mich., **353**, p. 1, 1937.

Belize, 2 (4200, W. A. Stanton; BM 1893-2-21-10).

The two specimens available, both males, have dorsals 23, ventrals 234 and 230, and caudals 59 and 56. They are thus clearly distinct from the Yucatecan *L. t. blanchardi* and agree with Peten specimens.

Adelphicos visoninus Cope

Rhegnops visoninus Cope, Proc. Acad. Nat. Sci. Phila., **1866**, p. 128, 1866—Honduras.

Adelphicus visoninus Cope, Bull. U. S. Nat. Mus., **32**, p. 85, 1887.

Silk Grass 1 (ITS 794, I. T. Sanderson); British Honduras, 1 (BM 1845-10-25-33, Dyson).

It is believed that all of the Dyson collection in the British Museum, labeled only "Honduras," should be referred to British Honduras. The Dyson specimen, a male, has 126 ventrals and 43 caudals, while the Sanderson specimen, a female, has 122 ventrals and 49 caudals. These are much the lowest ventral counts on record, while the female specimen recorded by Stuart from Peten (with 149 and 41) has the highest. Dr. Hobart M. Smith writes me that *Adelphicos quadrivirgatus* of authors includes several distinct forms. The above name for the species in British Honduras is tentatively supplied by him.

Sibynomorphus brevifacies Cope

Tropidodipsas brevifacies Cope, Proc. Acad. Nat. Sci. Phila., **1866**, p. 127, 1866—Yucatan.

Sibynomorphus brevifacies Amaral, Mem. Inst. Butantan, **4**, p. 196, 1929.

British Honduras, 1 (4234, W. A. Stanton).

The single specimen known from British Honduras consists of a head only.

Sibynomorphus sanniolus Cope

Mesopeltis sanniolus Cope, Proc. Acad. Nat. Sci. Phila., **1866**, p. 318, 1866—Yucatan.

Sibynomorphus sanniolus Amaral, Mem. Inst. Butantan, **4**, p. 199, 1929.

British Honduras, 1 (4247, W. A. Stanton).

The single specimen available has dorsals 15, ventrals 153, caudals 67, upper labials 9–9, lower labials 10–10, oculars 1–2 and 1–3, and temporals 1–2; the total length is 234, tail 66.

Coniophanes bipunctatus Günther

Coronella bipunctata Günther, Cat. Colubrine Snakes, p. 36, 1858—no locality.

Coniophanes bipunctatus Cope, Proc. Acad. Nat. Sci. Phila., 1866, p. 128, 1866.

Belize, 4 (USNM 24902, 26061, 55860, Parsons and W. A. Stanton; BM no No.); Belize, 40 miles inland, 1 (BM 1924–2–18–9, H. B. Newham); Stann Creek, 3 (BM 1890–6–18–1, 1890–10–24–6, 1891–3–4–5, J. Robertson); British Honduras, 3 (4235–37, W. A. Stanton).

The above series includes five males and six females; the dorsal scales number 21–21–17 in all; in males the ventrals range from 135 to 142, average 138, and in females from 135 to 147, average 140; the caudals in four males range from 89 to 94, and in the only two females with a complete tail number 72 and 85. It is extremely likely that the type actually came from Belize, which thus may be designated the type locality.

Coniophanes fissidens fissidens Günther

Coronella fissidens Günther, Cat. Colubrine Snakes Brit. Mus., p. 56, 1858—Mexico.

Coniophanes fissidens fissidens Bailey, Occ. Papers, Mus. Zool. Univ. Mich., 362, p. 5, 1937.

Bokowina, 1 (ITS 721, I. T. Sanderson); Cockscomb Mountains, northern slope, 1 (CM 8485, E. R. Blake and C. T. Agostini); Cohune Ridge, 1 (MZUM 80710, C. L. Lundell); Double Falls, 3 (ITS 811, 813, 808, I. T. Sanderson); Manatee, 1 (5825, B. H. Bailey); Silk Grass, 1 (ITS 689, I. T. Sanderson).

In four male specimens the ventrals range from 120 to 124 and the caudals from 80 to 85; in three female specimens the ventrals range from 129 to 132 and the caudals from 72 to 76.

Coniophanes imperialis clavatus Peters

Dromicus clavatus Peters, Monatsber. Akad. Wiss. Berlin, 1864, p. 388, 1864—Mexico.

Coniophanes imperialis clavatus Bailey, Occ. Papers, Mus. Zool. Univ. Mich., 362, p. 6, 1937.

Belize, 6 (4444–45, K. P. Schmidt and L. L. Walters; USNM 26064, 26355, Stanton and Bennett; ITS 859, I. T. Sanderson; BM

no No.); Kate's Lagoon, 1 (ITS 901, I. T. Sanderson); Stann Creek, 6 (USNM 50623, J. P. Lyman; ITS 856, I. T. Sanderson; BM 1890–5–12–2, 1890–5–13–1, 1890–10–24–5, 1891–2–4–2); British Honduras, 10 (4239–45, W. A. Stanton; BM 1894–12–28–26 to 28).

These specimens agree excellently with *clavatus* in Bailey's recent careful diagnosis of the forms of *imperialis* (Bailey, 1939).

Imantodes cenchoa Linnaeus

Coluber cenchoa Linnaeus, Syst. Nat., p. 226, 1758—America.

Imantodes cenchoa Duméril and Bibron, Erpét. Gén., 7, p. 1065, 1854.

Double Falls, 1 (ITS 819, I. T. Sanderson); Silk Grass, 1 (ITS 799, I. T. Sanderson).

Leptodeira annulata polysticta Günther

Leptodira polysticta Günther, Biol. Centr.-Amer., Zool., Rept. Amph., fasc. 22, p. 172, pl. 55, fig. A, 1895—Jalapa, Vera Cruz; Yucatan; Honduras; Belize; Panama.

Leptodeira annulata polysticta Smith, Proc. Biol. Soc. Wash., 54, p. 115, 1941—type loc. restr. to Belize.

Belize, 1 (BM no No., F. D. Godman); Belize, 40 miles inland, 1 (BM 1924–2–18–8, H. B. Newham); Cohune Ridge, 1 (MZUM 80717, C. L. Lundell); Grant's Works, 1 (ITS 823, I. T. Sanderson); Manatee, 1 (3481, B. H. Bailey); Northern Lagoon, 1 (BM 1845–8–5–24, Dyson); Stann Creek, 1 (USNM 26058, W. A. Stanton); British Honduras, 5 (4248, 4250–53, W. A. Stanton).

The dorsal scales vary from 19–21–15 to 21–23–17; ventrals in six males 198 to 211, average 205; in six females 190 to 206, average 200 (the reverse of the normal sex difference); caudals in six males 87 to 104, average 97; in six females 68 to 90, average 82.

L. a. polysticta is readily distinguished from *Leptodeira yucatanensis malleisi*, the only other species of the genus in British Honduras, in its smaller and more numerous dorsal spots, which number about 50 on the body, as compared with 25 to 40 larger blotches in *malleisi*.

Leptodeira yucatanensis malleisi Dunn and Stuart

Leptodeira yucatanensis malleisi Dunn and Stuart, Occ. Papers, Mus. Zool. Univ. Mich., 313, p. 1, 1935—Tuxpena, Campeche.

Belize, 10 (4446–47, K. P. Schmidt and L. L. Walters; USNM 24901, 24908, 26354, 52309, 56010–12, Parsons, Bennett, and W. A. Stanton; ITS 668, I. T. Sanderson); Kate's Lagoon, 2 (ITS 884–85, I. T. Sanderson); Manatee, 1 (3481, B. H. Bailey); British Honduras, 1 (4249, W. A. Stanton).

In these specimens the dorsal scales vary from 19–21–15 to 21–23–17; ventrals in seven males 177–188, average 182, in seven females 173–188, average 182; caudals in seven males 73–84, average 79, in seven females 67–80, average 72.

Clelia clelia Daudin

Coluber clelia Daudin, Hist. Nat. Rept., 6, p. 330, pl. 78, 1803—Surinam.

Clelia cloelia Stejneger, Proc. U. S. Nat. Mus., 45, p. 547, 1913.

Middlesex, 1 (4448, K. P. Schmidt and L. L. Walters).

Oxybelis acuminatus Wied

Coluber acuminatus Wied, Beitr. Naturg. Brasil., 1, p. 322, 1825—Espirito Santo River, Brazil.

Oxybelis acuminatus Steindachner, Reise Novara, Zool., 1, Rept. 1, p. 72, 1867.

Belize, 1 (USNM 55805, W. A. Stanton); Cohune Ridge, 1 (MZUM 80712, C. L. Lundell); San Agustin, 1 (MZUM 80711, C. L. Lundell); Stann Creek Valley, 1 (ITS 846, I. T. Sanderson).

Ventrals in two males 186, 193, and caudals 169, 174; in two females 195, 195, and 181, 189.

Oxybelis fulgidus Daudin

Coluber fulgidus Daudin, Hist. Nat. Rept., 6, p. 352, pl. 80, 1803—Surinam.

Oxybelis fulgidus Duméril and Bibron, Erpét. Gén., 7, p. 187, 1854.

Freetown, 1 (CM 8501, E. R. Blake and C. T. Agostini); British Honduras, 1 (BM 1895–2–21–5).

Both specimens are females with incomplete tails; the ventrals number 209 and 217.

Tantilla brevis Günther

Homalocranium breve Günther, Biol. Centr.-Amer., Zool., Rept. Amph., fasc. 19, p. 150, 1895—British Honduras.

British Honduras, 1 (BM 1890–4–24–35, type, Osbert Salvin).

The type of this species is still the only known specimen. It appears to me to be a female, and I count 108 ventrals instead of 111 as stated by Boulenger (1896, p. 226).

Stenorhina degenhardtii Berthold

Calamaria degenhardtii Berthold, Abh. Ges. Wiss. Göttingen, 3, p. 8, pl. 1, figs. 3–4, 1846—Mexico and Central America.

Stenorhina degenhardtii Jan, Arch. Zool. Anat. Physiol., 2, p. 63, 1862.

British Honduras, 1 (4218, W. A. Stanton).

This specimen, a female, has 175 ventrals and 33 caudals, and is uniform in coloration at a length of 490 mm.

The variability in color pattern of this snake, in its wide range from Ecuador to Mexico, is well known. It is not yet certain to what extent this may depend on ontogenetic change or on color dimorphism. The specimens from the Yucatan Peninsula have a notably higher number of ventrals in both sexes, 162–169 in males and 168–178 in females, as compared with the average in other parts of Central America. The specimen from Jalapa, Vera Cruz, recorded by Boulenger (1896, p. 230) may well be directly allied to this series; but a specimen from Zacapa, Guatemala, and one from Cartago, Costa Rica, with (respectively) 171 ventrals are anomalous. Yucatan specimens are uniform in coloration; but Stuart reports of the Peten series collected by himself that they are dimorphic, either quinquelineate or uniform. The type of *quinquelineatus* Hallowell, a specimen said to be from "Honduras," with ventrals 170, may be from British Honduras. It seems evident that it will be possible to partition this interesting form into subspecies when more material is available.

Micrurus affinis alienus Werner

Elaps alienus Werner, Zool. Anz., 26, p. 249, 1903—no locality.

Micrurus affinis alienus Schmidt, Field Mus. Nat. Hist., Zool. Ser., 20, p. 212, 1936.

Micrurus affinis stantoni Schmidt, Field Mus. Nat. Hist., Zool. Ser., 20, p. 36, 1933.

Belize, 5 (4204, W. A. Stanton; USNM 24906, 56611, Parsons and W. A. Stanton; BM no Nos., J. Gegg and Osbert Salvin); Belize River, 50 miles above Belize, 1 (MZUM, L. C. Stuart); Cocquericot, 1 (MZUM 74911, L. C. Stuart); Corozal Island, 1 (Munich 1922–81); Silk Grass, 1 (ITS 688, I. T. Sanderson); Stann Creek, 6 (USNM 26059, W. A. Stanton; BM 1890–9–8–5, 1891–3–4–6, J. Robertson; ITS 837, 848, 851, I. T. Sanderson); Valentin, 1 (MZUM 80721, C. L. Lundell); British Honduras, 12 (4201–03, 4254, W. A. Stanton; BM 1895–2–21–1 and 2, 6 no No.).

The ventrals and caudals in the above series in sixteen male specimens range from 199 to 214 and from 47 to 59; in ten females from 212 to 226 and 37 to 42. The temporals are 1–2 in all but two of the male specimens; 1–1 in two, 1–½ in one, and 1–2 in seven of the females. The black rings range from 18+4 to 44+7 in females and from 18+6 to 29+9 in males; there is a tendency to a light mark on the snout; undivided caudals are somewhat more uniformly present in male specimens (in 13 out of 16 specimens), averaging 15; in female specimens they average 6.

The reasoning by which the name *alienus* is allocated to this form has been set forth elsewhere. The differences between the present form and its nearest ally, *M. affinis mayensis*, lie principally in its conspicuously more numerous black rings, in the tendency to irregularity of the rings, and in a higher average of ventrals in both sexes. To the west it can be traced into Peten and Campeche, presumably intergrading in Vera Cruz with *a. affinis*, in Alta Verapaz with *a. apiatus*, and in the Guatemalan coastal strip perhaps with *a. hippocrepis*, or with the form, as yet unknown, which may inhabit the Lake Izabal Valley. This hypothetical intergradation in four directions would be of considerable theoretic interest; it is unfortunately not yet demonstrated by specimens from the critical areas.

Certain specimens in the above list are difficult to interpret. BM 1895-2-21-1 to 4, with no locality except British Honduras, and BM 1891-3-4-6, from Stann Creek, together with the specimens of the Sanderson collection, have relatively few black rings. The problem raised by their non-agreement with the great majority of specimens from the area can be solved only by additional material.

A specimen in the Zoologisches Museum, Berlin, falls entirely outside the definition of *alienus*. It is said to be from Corozal Island, British Honduras, with no source stated except "Wien." There is a normal specimen in the Munich Museum from this locality. The Berlin specimen is a good-sized male with very well-developed supra-anal tubercles, which are otherwise wholly absent in the coral snakes of this area. Some confusion of data is suspected.

Agkistrodon bilineatus Günther

Ancistrodon bilineatus Günther, Ann. Mag. Nat. Hist., (3), 12, p. 364, 1863—Pacific coast of Guatemala.

Belize, 1 (BM b, P. L. Sclater); British Honduras, 1 (4196, W. A. Stanton).

Trimeresurus atrox Linnaeus

Coluber atrox Linnaeus, Syst. Nat., p. 22, 1758—Asia [in error].

Trimeresurus atrox Schmidt and Andrews, Field Mus. Nat. Hist., Zool. Ser., **20**, p. 182, 1936.

Bokowina, 1 (ITS 737, I. T. Sanderson); Freetown, 1 (CM 8512, E. R. Blake and C. T. Agostini); Kate's Lagoon, 1 (ITS 877, I. T. Sanderson); Stann Creek, 2 (USNM 50622, J. P. Lyman; BM 1891-3-4-7, J. Robertson); Valentin, 1 (MZUM 80726, C. L. Lundell); British Honduras, 1 (4197, W. A. Stanton).

Trimeresurus nummifer nummifer Rüppel

Atropos nummifer Rüppel, Mus. Senck., **3**, p. 21, 1845—Mexico.

Trimeresurus nummifer nummifer Dunn, Proc. Biol. Soc. Wash., **52**, p. 165, 1939.

Cohune Ridge, 1 (MZUM 80724, C. L. Lundell); Double Falls, 2 (ITS 812, 821, I. T. Sanderson); Esperanza, 1 (MZUM 80722, C. L. Lundell); Valentin, 1 (MZUM 80723, C. L. Lundell).

In four female specimens the ventrals number 126, 128, 130, and 131, and the caudals 32, 34, 32, and 31. The single male specimen known from the colony has ventrals 121, caudals 34.

Trimeresurus yucatanicus Smith

Trimeresurus yucatanicus Smith, Zoologica, **26**, p. 62, 1941—Chichen Itza, Yucatan.

Benque Viejo, 1 (U.S.N.M. 61781, A. Versanel).

With only a single specimen of the *lansbergii* group available from British Honduras it is preferable to refer it to the nearest geographically related form.

Trimeresurus schlegelii Berthold

Trigonocephalus schlegelii Berthold, Abh. Ges. Wiss. Göttingen, **3**, p. 13, pl. 1, figs. 5, 6, 1846—Colombia.

Valentin, 1 (MZUM 80725, C. L. Lundell).

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NOTES ON A COLLECTION OF BIRDS FROM MICHOACAN, MEXICO

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NOTES ON A COLLECTION OF BIRDS FROM MICHOACAN, MEXICO

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The following paper is based on a series of 481 Michoacan birds collected for Field Museum during the summers of 1940 and 1941 by two Mexican expeditions led by Mr. Harry Hoogstraal of the University of Illinois.

Preliminary faunal surveys undertaken by Mr. Hoogstraal during two previous field trips in northern and eastern Mexico had indicated the desirability of making comparative studies, of a more detailed nature, in a southwestern state. Michoacan was selected because its geographical position and varied topography afforded unlimited opportunities for the ecological and faunistic studies desired. A representative portion of the state, incorporating most of the physical and climatic features of the Mexican plateau and of the Pacific lowlands, was found in the region lying between the Rio Tepalcatepec and the summit of Cerro de Tancítaro. Several specialists, including a botanist, an ornithologist, a mammalogist, a herpetologist and an entomologist, were enlisted to make collections in their respective fields as a means of determining the faunal affinities and the vertical extent of life zones in this area. The present report on the bird life of the Rio Tepalcatepec–Cerro de Tancítaro transect, despite limitations of data, is presented as a basis for more ambitious investigations in southwestern Mexico.

History

Michoacan occupies a region of considerable interest to the naturalist because of its relationship to the central plateau, but biologically it is today one of the least-known of the Mexican states. Its ornithology, particularly, has been neglected and the student can, with few exceptions, search the literature in vain for more than casual reference to specimens collected within its borders. Some indication of the status of Michoacan ornithology is shown by the fact that no less than 75 forms, or 52 per cent of the 144 treated in the present paper, apparently constitute new state records. Fifteen of these may be considered definite extensions of range but the majority involve common species of general distribution in southwestern Mexico.

The first and perhaps largest representative collection of Michoacan birds ever made was obtained by Edward W. Nelson and Edward A. Goldman fifty years ago during the course of their extensive Mexican explorations for the Biological Survey. This collection,

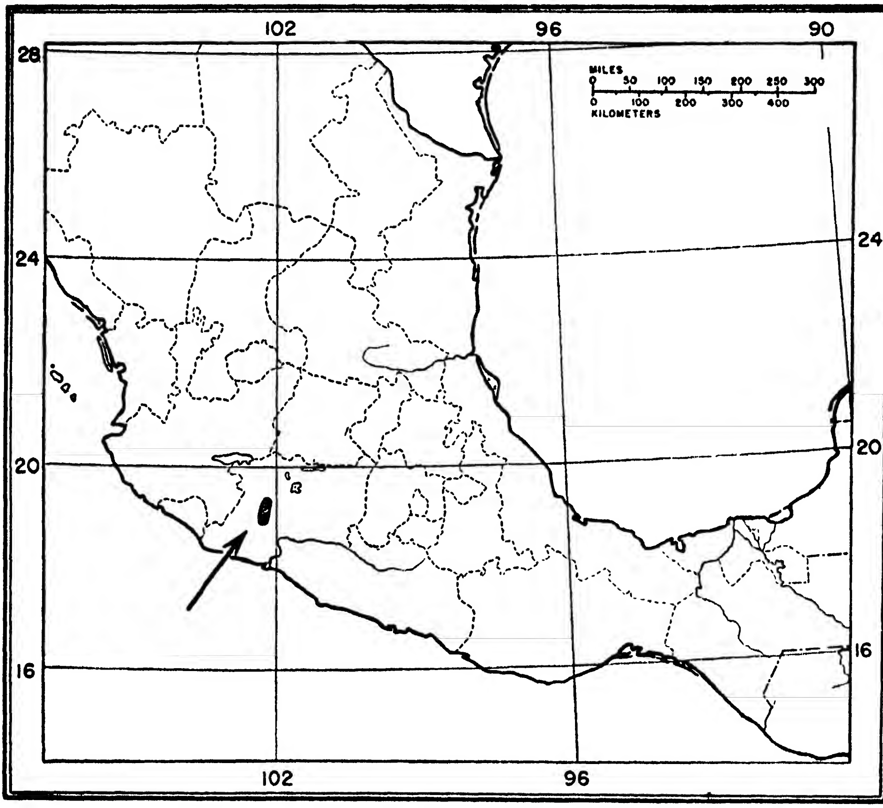

FIG. 39. Map of Mexico, showing location of Rio Tepalcatepec–Cerro de Tancítaro transect.

totaling approximately 500 specimens, has not been worked up as a unit but was the source of most of Ridgway's Michoacan records.

The Mexican itinerary of Nelson and Goldman has not been published, but the following details of their travels in Michoacan have been assembled at our request from the records of the United States Fish and Wildlife Service, by Dr. John W. Aldrich.

1892. Edward W. Nelson:

July 14–August 4; October 15–16. Patzcuaro.
August 4–10. Querendaro.
October 8–15. Nahuatzin.

1893. Edward W. Nelson and Edward A. Goldman:

January 11–25. Zamora.

January 27–February 5. Cerro Patamban and Tinguindin.

February 5–19. Los Reyes.

February 20–March 4. Cerro de Tancítaro and Perivan.

March 9–24. La Salada and Uruapan.

March 24–30. Route from La Huacana and Volcan de Jorullo to Balsas; also in the vicinity of Ahuacana.

Scarcely less extensive are the collections made for Field Museum by the recent Hoogstraal expeditions. The village of Tancítaro, which is located on a plateau adjacent to the southern base of Cerro de Tancítaro, served as headquarters for both expeditions. A total of 481 specimens representing 140 forms was obtained along a transect between the Rio Tepalcatepec and the summit of Cerro de Tancítaro by the junior author (1940) and by Dr. Reed W. Fautin (1941). The list of localities visited by them is as follows:

1940. Harold C. Hanson; 232 specimens, 96 species.

July 14–19. Tancítaro.

July 20–22. Upper slopes and summit of Cerro de Tancítaro.

July 23–25. Tancítaro.

July 26–August 1. Cloud forest of Cerro de Tancítaro.

August 2–8. Tancítaro.

August 9–14. Vicinity of Apatzingan.

August 15–17. Tancítaro.

1941. Reed W. Fautin; 249 specimens, 112 species, including 44 additions to the 1940 collection.

June 23–28. Tancítaro.

June 29–July 7. Cloud forest of Cerro de Tancítaro.

July 8–9. Tancítaro.

July 10–25. Cloud forest to summit of Cerro de Tancítaro.

July 26–August 7. Tancítaro.

August 8–27. Vicinity of Apatzingan and Acahuato.

Additional Michoacan birds have been collected at random by various travelers, but these are widely scattered and details of their present disposition are not available. The veteran collector Chester C. Lamb has worked more or less extensively in the state and certain of his specimens have been preserved in the collection of Robert T. Moore. It is evident, however, that far more field work must be carried out before a satisfactory list of Michoacan forms can be prepared.

SPECIES NOT PREVIOUSLY RECORDED IN MICHOACAN

Heterocnus mexicanus fremitus
Cochlearius cochlearius zeledoni
Plegadis (falcinellus?) guarauna
Cairina moschata
Coragyps atratus
Cathartes aura aura
Chondrohierax uncinatus subsp.
**Accipiter striatus suttoni*
Buteo jaimaicensis costaricensis
Buteo brachyurus
Buteo nitidus plagiatus
Parabuteo unicinctus harrisi
Micrastur semitorquatus naso
Polyborus cheriway audubonii
Falco albigularis albigularis
Ortalis vetula poliocephala
Actitis macularia
Leptotila verreauxi angelica
Aratinga canicularis eburnirostrum
**Rhynchopsitta pachyrhyncha*
Crotophaga sulcirostris sulcirostris
Tyto alba pratincola
**Nyctibius griseus mexicanus*
Nyctidromus albicollis yucatanensis
**Aëronautes saxatalis nigrior*
**Lampornis amethystinus brevirostris*
Megaceryle torquata torquata
Chloroceryle amazona
Chloroceryle americana septentrionalis
**Dryobates arizonae fraterculus*
Attila spadiceus pacificus
Tyrannus melancholicus occidentalis
Tyrannus crassirostris crassirostris
Myiodynastes luteiventris luteiventris
Pitangus sulphuratus derbianus
Iridoprocne albilinea albilinea
Corvus corax sinuatus
Calocitta formosa formosa
Cyanocitta stelleri coronata
Parus sclateri sclateri
Sitta carolinensis mexicana
**Certhia familiaris guerrerensis*
Cinclus mexicanus mexicanus
**Thryothorus pleurostictus nisorius*
**Thryomanes bewickii percnus*
**Turdus migratorius permixtus*
Polioptila plumbea bairdi
**Regulus regulus clarus*
Ptilogonys cinereus pallescens
**Vireolanius melitophrys goldmani*
**Vireo bellii medius*
Vireo solitarius repetens
Vireo virescens flavoviridis
Vireo gilvus subsp.
Mniotilta varia
**Compsothlypis pitiayumi pulchra*
Peucedramus olivaceus olivaceus
Dendroica occidentalis
Myioborus miniatus miniatus
Cassiculus melanicterus
Icterus spurius
Icterus wagleri wagleri
Icterus pustulatus pustulatus
Tanagra musica elegantissima
Piranga flava hepatica
Piranga bidentata bidentata
Passerina versicolor subsp.
Passerina leclancherii leclancherii
**Hesperiphona abeillei abeillei*
Volatinia jacarina diluta
Spinus notatus griscomi
Loxia curvirostra stricklandi
Arremonops rufivirgatus sumichrasti
Aimophila humeralis humeralis
Aimophila ruficauda acuminata

* Indicates extension of range.

TOPOGRAPHY AND LIFE ZONES[1]

The transect chosen for intensive study in Michoacan extends approximately thirty-seven miles from the sweltering valley of the Rio Tepalcatepec northward to the summit of Cerro de Tancítaro[2]

[1] Botanical determinations employed throughout this report were made by Paul C. Standley and Julian A. Steyermark, Curator and Assistant Curator of the Herbarium in Field Museum, from specimens and field studies prepared by William Leavenworth, expedition botanist. Certain physical and botanical data, particularly those pertaining to plant associations, have been drawn freely from notes prepared by Mr. Hoogstraal. The authors assume full responsibility, however, for their arrangement of life zones and for all ornithological data.

[2] This transect lies within one of the most poorly mapped regions of Mexico. Maps which have been consulted vary considerably in their estimates of the altitudes of Cerro de Tancítaro and other Michoacan localities. Therefore, all elevations discussed in this report are based upon aneroid readings obtained, and repeatedly checked, by members of the 1941 expedition.

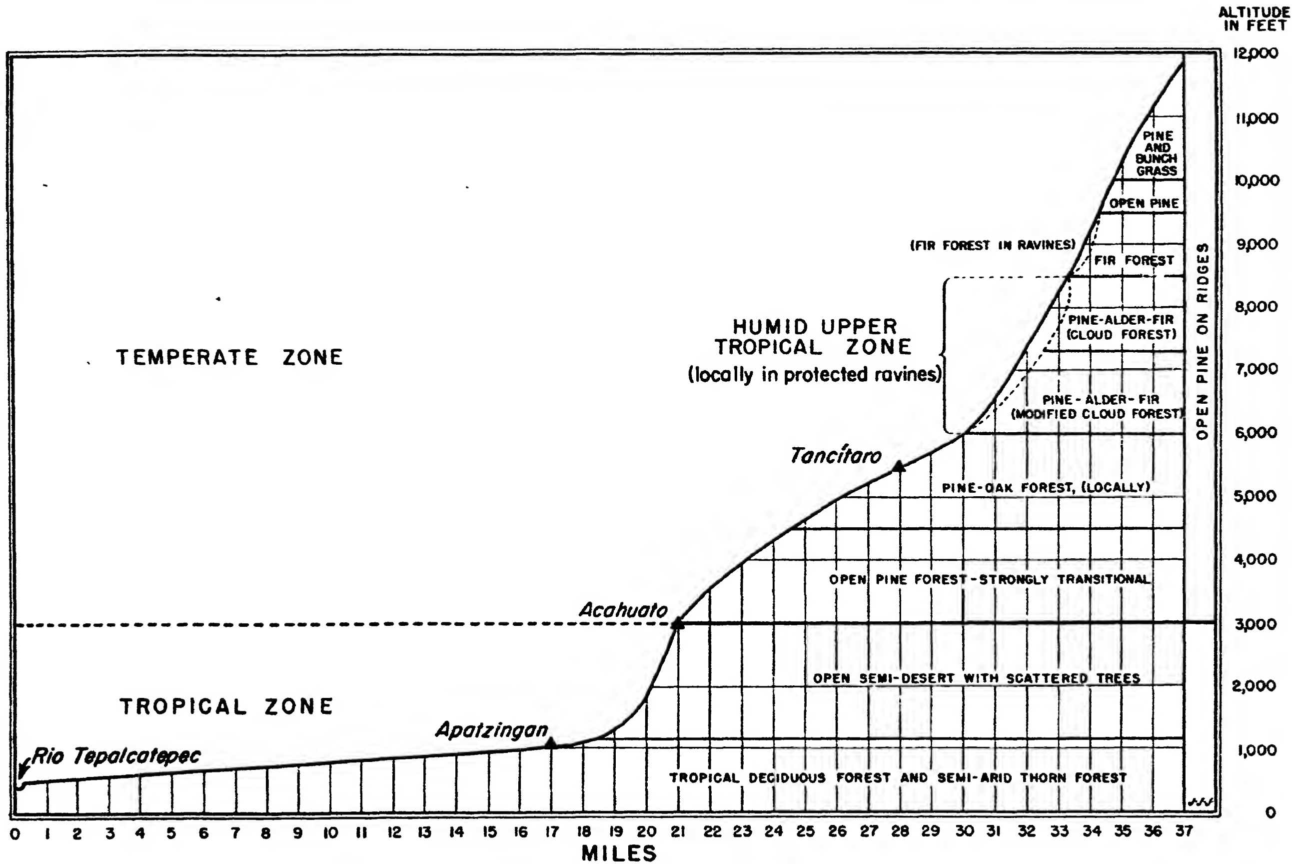

FIG. 40. Diagram of life-zone subdivisions of the Rio Tepalcatepec–Cerro de Tancítaro transect. Vertical exaggeration ×16.

and embraces an ascent of some eleven thousand feet. Not included in the area of investigation, but nevertheless exerting considerable influence on its rainfall and plant associations, is a spur of the Sierra Madre del Sur of Guerrero, which extends about seventy-five miles along the coast of Michoacan south of the Rio Tepalcatepec.

North of Cerro de Tancítaro, and adjacent to the vast, triangular-shaped inland plateau, or *mesa central* of Mexico, is a rugged area of mountain masses. Cerro de Tancítaro is an outlier of the mountains bordering the plateau, and is at the western end of a short, apparently isolated range running east and west for twenty miles or more. The mountains of this area are a part of the row of recent volcanoes which lie along the nineteenth parallel from Colima to the vicinity of Mexico City and which comprise one of the most actively volcanic regions on the continent.

The biotic and climatic characteristics of the transect may be outlined as follows:

- I. Arid Tropical Zone (Tierra Caliente). Rio Tepalcatepec to the lower (southern) slope of the Tancítaro plateau at Acahuato (500–3,000 ft.).
  - A. Tropical Deciduous Forest.
  - B. Arid and Semi-Arid Thorn Forest (semi-desert scrub).
  - C. Open Semi-Desert with scattered trees (1,200–3,000 ft.).
- II. Humid Upper Tropical Zone[1] (6,000–8,500 ft.).
  - A. Cloud Forest (locally, in humid ravines).
    - 1. Transitional or Modified Pine–Alder–Fir Association (6,000–7,300 ft.).
    - 2. Typical Pine–Alder–Fir Association (7,300–8,500 ft.).
- III. Temperate Zone (Tierra Templada). Lower (southern) slope of the Tancítaro plateau above Acahuato to the summit (3,000–11,800 ft.).
  - A. Open Pine Forest, strongly transitional (3,000–4,500 ft.).
  - B. Pine–Oak Forest (4,500–6,000 ft., locally).
  - C. Fir Forest (8,500–9,500 ft.).
  - D. Open Pine Forest, almost purely temperate (4,500–11,800 ft.).
    - 1. High Bunch Grass (10,000–11,800 ft., locally).

ARID TROPICAL ZONE

The Arid Tropical Zone, known locally as the tierra caliente, occupies a wide, arid valley having an average altitude of approximately 1,200 feet. There is little seasonal variation in temperature. Some rain falls during the summer months but it quickly drains and is of little value to agriculture, which depends on irrigation to a considerable extent. Leguminous and other thorn-studded bushes

[1] Subtropical Zone or "Mountain Rain Forest" of Chapman.

and cacti are often present, and there are numerous climbing cacti, hanging vines and impenetrable thickets. No humid tropical jungle exists in this region but along the river and other permanent sources of water there is a well-developed deciduous forest. This becomes more arid in general aspect as one leaves the river, its undergrowth is less luxuriant, and a tall fig tree (*Ficus*) often becomes dominant.

Several distinct plant associations may be recognized in this zone. A thorn forest or semi-desert scrub varies, depending on aridity, from open plain with scattered thorn trees and few herbs to dense stands of thorny trees with a light ground cover of herbs and shrubs. These trees, which include such common genera as *Acacia*, *Mimosa*, and *Caesalpinia*, range from eight to twenty feet in height and tend to grade into the tropical deciduous forest near water. Just north of Apatzingan, on the slope leading up to the Tancítaro plateau, there is a strip of even greater aridity. It is a pronounced semi-desert and supports only widely scattered trees, principally of non-leguminous genera.

SPECIES CHARACTERISTIC OF THE ARID TROPICAL ZONE

Ortalis vetula poliocephala	*Calocitta formosa formosa*
Amazona finschi finschi	*Turdus rufo-palliatus rufo-palliatus*
Piaya cayana mexicana	*Cassiculus melanicterus*
Trogon citreolus	*Icterus pustulatus pustulatus*
Momotus mexicanus mexicanus	*Passerina leclancherii leclancherii*
Centurus chrysogenys flavinuchus	*Arremonops rufivirgatus sumichrasti*
Xiphorhynchus flavigaster mentalis	*Aimophila humeralis humeralis*
Tyrannus crassirostris crassirostris	*Aimophila ruficauda acuminata*

Bird life in the Arid Tropical Zone is rather limited in species but individuals are often surprisingly abundant locally. Distribution depends primarily upon the habitat requirements of the various species, altitude being of little or no direct consequence. Approximately 43 per cent of the 144 forms collected or identified by sight were recorded only below 3,000 feet, which may be regarded as the upper limits of this zone. Analysis of these, after eliminating species of no faunal significance, indicates a preponderance of forms characteristic of the West Mexican Arid Tropical Fauna only partially suggested by the preceding list.

HUMID UPPER TROPICAL ZONE

Above the Tancítaro plateau certain valleys and protected slopes support a generally dense and humid forest which is basically homologous to the characteristic subtropical vegetation of mountainous regions to the southward. The subtropical or cloud forest is dis-

tributed locally from 6,000 to 8,500 feet and probably this is its northernmost appearance in western Mexico.

Two divisions of the Humid Upper Tropical Zone may be identified botanically. From approximately 6,000 to 7,300 feet there is a somewhat open and modified pine–alder–fir association with heavy, though not impenetrable undergrowth. A more typical cloud forest, characterized by excessive humidity and an extremely heavy growth of epiphytic bryophytes, pteridophytes and lichens, extends upward to 8,500 feet. It consists of a dense pine–alder–fir forest and numerous herbs and shrubs.

Cloud forests are indicative of the Humid Upper Tropical Zone and attain their maximum development in the central and northern Andes of South America. They become progressively less extensive and luxuriant as one proceeds northward through Central America to southern Mexico and there is a parallel decline in distinct faunal representatives. Cerro de Tancítaro supports only a meager northern outpost of cloud forest and lacks even the characteristic tree ferns and large bromeliads. The relative barrenness and insignificance of this zone in Michoacan is indicated by the fact that only two birds which may be regarded as indicators were found in the transect as compared with twenty-one recorded in Guerrero (nine endemic), forty in Guatemala, and forty-five in El Salvador.

SPECIES CHARACTERISTIC OF THE HUMID UPPER TROPICAL ZONE

Henicorhina leucophrys festiva	*Basileuterus belli clarus*

TEMPERATE ZONE

Proximity to the central Mexican plateau, which serves as a vast reservoir of Temperate Zone life, is reflected in every aspect of the Cerro de Tancítaro area. Plants and animals of temperate or even boreal affinities dominate the upper slopes of the mountain. Many forms overflow across the Tancítaro plateau to approximately 3,000 feet altitude where the moderating effects of the Arid Tropical Zone are manifested. There is no sharp line of demarcation between the two but the lower or southern slope of the Tancítaro plateau above Acahuato may be designated arbitrarily as the point at which the temperate element finally disappears.

The climate of the plateau[1] is relatively cool throughout the year, being hottest in April and May and coldest in December and January, when light snow occasionally falls. During the summer

[1] Refers to the Tancítaro plateau unless otherwise designated.

months the temperature ranges from 59° to 68° F. during the daytime and from 57° to 61° at night. Rain falls almost daily between June and October and is particularly heavy at the northern end of the plateau in the vicinity of Tancítaro. The upper slopes of the mountain receive less rainfall but are considerably colder.

A pine forest (*Pinus ayacahuite* and/or *P. montezumae*) of varying density covers the plateau and extends upward on exposed ridges to the summit of Cerro de Tancítaro. Herbs and shrubs which grow on the fairly steep slope between 3,000 and 4,500 feet are markedly transitional in character and include both tropical and temperate species. The flora becomes increasingly temperate above 4,500 feet, and oaks, willows, lindens, haws, ashes, and alders appear locally. Shrubs of the genera *Viburnum, Ceanothus, Solanum, Tournefortia, Lythrum, Cornus, Lobelia, Salvia, Arctostaphylos,* and *Cassia* are common. Herbs are particularly abundant and include *Piqueria, Drymaria, Cuphea, Borreria, Euphorbia, Ranunculus, Thalictrum, Verbena, Physalis, Plantago, Oxalis, Sisyrinchium, Hypoxis, Cynoglossum, Phaseolus,* and *Crotalaria.* Close stands of fir (*Abies religiosa*) become locally dominant between 8,500 and 9,500 feet and the ground cover is more limited.

The flora is less varied above 10,000 feet and vegetation becomes relatively sparse. With the disappearance of alders and firs only pines (*Pinus montezumae* var. *rudis*) and a few junipers (*Juniperus mexicanus*) remain as arboreal representatives. High, tough bunch grasses cover the ground and several herbs, including lupine (*Lupinus persistens*), are common. Only one shrub (ericaceous *Pernettia ciliata*) is found in the open pine forest of the upper slopes. Cerro de Tancítaro has no timberline, and hence lacks a true sub-alpine forest.

The influence of the central Mexican plateau, with its wealth of Temperate Zone life, is no less apparent in the avifauna of the Cerro de Tancítaro area. Approximately 62 per cent of the species which were restricted to that part of the transect characterized by predominantly temperate flora are true indicators of that zone. None of these were reported below 3,000 feet and it is probable that many do not occur even in the area of transition at the southern or lower end of the plateau.

SPECIES CHARACTERISTIC OF THE TEMPERATE ZONE

Buteo jaimaicensis costaricensis
Columba fasciata fasciata
Otus trichopsis trichopsis
Otus minutissimum gnoma
Aëronautes saxatalis nigrior
Hylocharis leucotis leucotis

Lampornis amethystinus brevirostris
Trogonurus mexicanus
Balanosphyra formicivora formicivora
Dryobates villosus jardinii
Myiochanes pertinax pertinax
Empidonax difficilis occidentalis
Empidonax fulvifrons rubicundus
Corvus corax sinuatus
Aphelocoma sordida sieberii
Cyanocitta stelleri coronata
Parus sclateri sclateri
Sitta pygmaea flavinucha
Certhia familiaris guerrerensis
Cinclus mexicanus mexicanus
Heleodytes megalopterus megalopterus
Troglodytes brunneicollis colimae
Turdus migratorius permixtus
Myadestes obscurus occidentalis
Catharus occidentalis fulvescens
Regulus regulus clarus
Ptilogonys cinereus pallescens
Vireolanius melitophrys goldmani
Vireo huttoni mexicanus
Diglossa baritula baritula
Vermivora superciliosa palliata
Peucedramus olivaceus olivaceus
Myioborus miniatus miniatus
Ergaticus ruber ruber
Icterus wagleri wagleri
Piranga flava hepatica
Piranga bidentata bidentata
Hesperiphona abeillei abeillei
Spinus pinus macropterus
Spinus notatus griscomi
Loxia curvirostra stricklandi
Pipilo ocai nigrescens
Atlapetes pileatus pileatus
Atlapetes torquatus virenticeps
Plagiospiza superciliosa superciliosa

Distribution of birds in the Temperate Zone is more circumscribed than in the Arid Tropical Zone where altitude is a minor factor and plant associations are less differentiated. Two species, *Sitta pygmaea flavinucha* and *Plagiospiza s. superciliosa,* apparently are restricted to the pine–bunch grass association near the summit of the mountain. Several species other than the two indicators of the Humid Upper Tropical Zone already mentioned were recorded only in the cloud forest. Among these were *Cyanocitta stelleri coronata, Cinclus m. mexicanus, Heleodytes m. megalopterus, Catharus occidentalis fulvescens, Ergaticus r. ruber,* and *Atlapetes torquatus virenticeps.*

Birds that occupied a considerable vertical range in the transect were more or less closely associated with the coniferous forests. A few of these also occurred in deciduous forests and areas of mixed growth but it is notable that only *Empidonax difficilis occidentalis* was equally at home in the cloud forest. The following species have an extensive vertical distribution in the Temperate Zone: *Hylocharis l. leucotis, Lampornis amethystinus brevirostris, Colaptes cafer mexicanus, Balanosphyra f. formicivora, Dryobates villosus jardinii, Empidonax difficilis occidentalis, Aphelocoma sordida sieberii, Parus s. sclateri, Certhia familiaris guerrerensis, Troglodytes brunneicollis colimae, Sialia mexicana australis, Peucedramus o. olivaceus, Junco phaeonotus australis.* Two species, *Cathartes a. aura* and *Rhynchopsitta pachyrhyncha,* occur at all altitudes from the tierra caliente to the upper slopes of the mountain.

An indication of the composition and relative importance of the three life zones included in the Rio Tepalcatepec–Cerro de Tancítaro transect may be found in the following numerical analysis of their respective bird populations.

	No. of species in zone	% of total no. in transect	Indicator Species: No. in zone	Indicator Species: % of total no. in zone	Indicator Species: % of total no. in transect
Arid Tropical Zone	63	43.8	16	25	11.0
Humid Upper Tropical Zone	8	5.5	2	25	1.3
Temperate Zone	73	50.7	45	62	32.0
Total number in transect	144				

Comparison with the ornithology of adjacent areas is essential in any local study of birds. Griscom's (1934) pioneering work in Guerrero constitutes the only modern and reasonably complete Mexican state list available and hence is of inestimable value to the student of bird life in southwestern Mexico.

The limited scope of the present report prohibits extensive or precise comparisons between the avifaunas of Michoacan and Guerrero. However, there are sufficient data to indicate basic differences between the two. No less than sixty-four species and subspecies recorded in this transect, i.e., 44 per cent of the total, are unknown in Guerrero. These sixty-four forms, representing fifty-nine genera, include twenty-seven genera and twenty species absent in Guerrero (other genera and species being represented in that state by different species or subspecies). Additional field work in Guerrero can be expected to reduce this apparent discrepancy considerably.

Analysis of the Michoacan faunal and life zone indicators which are unrecorded in Guerrero is no less interesting. Twenty-four birds, including eighteen species and ten genera, which are characteristic of the Temperate Zone in Michoacan, are not known from Guerrero. The valley of the Rio Balsas undoubtedly excludes many temperate species from that state but evidently a much closer affinity exists between Michoacan and the central Mexican plateau. On the other hand, the West Mexican Arid Tropical Fauna is almost continuous in Michoacan and Guerrero. Only three characteristic birds, including two species, which occur in the former state are lacking in the latter. Attention has been called previously to the poverty of the Humid Upper Tropical Zone on Cerro de Tancítaro, which lacks a single endemic bird as compared with nine found in the cloud forests of Guerrero.

The authors are indebted to several individuals and institutions for assistance and co-operation in the preparation of this report. Much credit is due Mr. Harry Hoogstraal for his capable leadership of the expeditions which collected all the specimens listed. We are

particularly grateful to him for so generously making his extensive field notes available to us. Numerous species were added to the Michoacan list through the diligence of Dr. Reed W. Fautin, ornithologist of the 1941 expedition, and certain field observations made by him have been most useful in corroborating or supplementing those of the junior author. Valuable assistance in the field was also given by Dr. Kenneth Knight and Mr. Jerome Van Gorkom in 1940 and by Mr. Ralph Haag in 1941.

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LIST OF SPECIES

Heterocnus *mexicanus fremitus* van Rossem and Hachisuka

Apatzingan: 2 females, August 19 and 24.

Cochlearius cochlearius zeledoni Ridgway

El Capiere, Rio Tepalcatepec: 1 male, August 2.

Plegadis (falcinellus?) guarauna Linnaeus

A number of glossy ibis were observed along the Rio Tepalcatepec in August, 1940, by Kenneth Knight. None were collected.

Cairina moschata Linnaeus

Apatzingan: 1 female, August 10.

Muscovy ducks were found only in the tierra caliente. They were most numerous in ponds and along streams in the tropical deciduous forest. A family of flightless birds was observed by Fautin on August 18.

Coragyps atratus Bechstein

Black vultures were limited to the tierra caliente and were frequently seen soaring over the arid slopes leading to the plateau where the ascending currents of hot air facilitated flight. They

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2

3

LOWLAND IN VALLEY OF RIO TEPALCATEPEC

Fig. 1. Tropical deciduous forest. **Fig. 2.** Semi-desert scrub with columnar cactus.
Fig. 3. View toward Cerro de Tancítaro from the valley.

1

2

TANCÍTARO PLATEAU, TEMPERATE ZONE

Fig. 1. Pine-oak association; altitude about 5,000 feet.
Fig. 2. Cultivated land near village of Tancítaro.

were most abundant in the Apatzingan area in which they exceeded turkey vultures to a considerable extent.

Cathartes aura aura Linnaeus

Apatzingan: 1 male, August 8.

Cerro de Tancítaro, 1 male, July 18.

The western turkey vulture, *Cathartes aura teter*, ranges southward over the Mexican plateau to Michoacan but is replaced by the nominate race on Cerro de Tancítaro and in the adjacent lowlands. Measurements of the Apatzingan and Cerro de Tancítaro specimens: wing 500 and 487, tail 254 and 240, as compared with the extremes of 480–528 (wing) and 252–282 (tail) designated for *teter*.

Turkey vultures occurred in the lowlands south and west of Cerro de Tancítaro in company with the ubiquitous black vulture but were far more numerous on the plateau. Although none were seen on the upper slopes of the mountain, it is probable that these vultures occur at random wherever food is available, for there is no evidence that altitude acts as a limiting factor in their vertical distribution.

Chondrohierax uncinatus subsp.

Apatzingan: 1 male, August 15.

The complicated plumages of the hook-billed kites, involving varieties within phases, have been discussed in detail by Friedmann (1934), who recognizes two races in Mexico. Michoacan lies between the known ranges of these forms. The present specimen, with badly worn primaries and rectrices, constitutes the first specific record of the occurrence of *uncinatus* in that state. As might be expected, the characters of *aquilonis* and of the nominate race are so combined in this bird that it could be regarded as an individual variant of either. In darkness of plumage it resembles the former, but the white ventral bars are even narrower than are those of South American specimens of *uncinatus* which we have examined. The measurements are wing 302, tail 215, culmen from cere 33.

Accipiter striatus suttoni van Rossem

Cerro de Tancítaro: 1 male, August 13.

This specimen, in immature plumage, is readily separable from typical *velox* of comparable age both on the basis of size (wing 179, tail 142) and of color. The under parts are somewhat paler and in general much redder than in *velox*, and broad linear stripes obscure

the pectoral area. The immaculate chestnut or reddish thighs and lower flanks which characterize *suttoni* are particularly well marked in the Cerro de Tancítaro specimen.

Buteo jaimaicensis costaricensis Ridgway

Between Patzcuaro and Comanje: 1 male, July 10.

Cerro de Tancítaro: 1 female, 2(?), July 20–August 3.

Two of the four resident red-tailed hawks collected in the vicinity of Cerro de Tancítaro are melanistic and have their sub-terminal tail bands more pronounced than in any other specimens of *costaricensis* examined. The other two agree with typical specimens from Honduras and El Salvador in being uniformly dark above, sparsely marked below, and in having their abdomens and thighs washed with immaculate reddish ochraceous.

The stomach of one hawk contained the remains of a small unidentified bird and a partially formed hair pellet of a rodent.

Buteo brachyurus Vieillot

Cerro de Tancítaro: 1(?), July.

A single immature short-tailed hawk collected by Ralph Haag on the plateau exhibits a striking degree of erythrism. The natural color of the head and dorsal parts is considerably intensified and flushed with reddish brown. The flanks, thighs and under wing coverts are so thoroughly washed with reddish chestnut as to obscure the normal streaks and spots of the under parts.

Buteo nitidus plagiatus Schlegel

Apatzingan: 3 females, August 12–21.

This form is included in the genus *Buteo* for reasons which have been advanced by van Rossem (1934, p. 429).

Parabuteo unicinctus harrisi Audubon

Apatzingan: 1 male, August 22.

Micrastur semitorquatus naso Lesson

Apatzingan: 1 female, August 24.

Polyborus cheriway audubonii Cassin

Apatzingan: 1 male, August 24.

Falco albigularis albigularis Daudin

Ten miles south of Cerro de Tancítaro: 1 female, August 8.

There seem to be insufficient grounds for resurrecting the northern race *petoensis* Chubb.

Yellow breast feathers of a small bird, possibly *Atlapetes pileatus virenticeps*, were found in the stomach of this falcon.

Ortalis vetula poliocephala Wagler

Cerro de Tancítaro: 1 female, August 17.

This specimen was a captive bird taken by the natives at San Juan, a village near Tancítaro.

Philortyx fasciatus Gould

Apatzingan: 2 males, 3 females, August 8–22.

Two coveys of 12 to 15 birds each were seen by the junior author in an old field of dense herbaceous cover and brush islands near Apatzingan. The testes of the males were still slightly enlarged in August and the oviduct of one female contained a hard-shelled egg.

Two stomachs were examined. Both contained a few small seeds and the remains of many leaf beetles (Chrysomelidae). One bird had also fed upon lepidopterous larvae.

Cyrtonyx montezumae montezumae Vigors

Tancítaro: 1 male, July 4.

Jacana spinosa spinosa Linnaeus

Apatzingan: 1 male, August 10.

Actitis macularia Linnaeus

Apatzingan: 1 male, August 20.

Columba fasciata fasciata Say

Tancítaro: 6 males, 2 females, July 21–August 4.

Band-tailed pigeons were fairly abundant in the tierra templada but were concentrated principally in the pine and oak forests between 4,500 and 6,000 feet altitude. Several small flocks, totaling approximately twenty-five individuals, frequented a grove of tall trees near a watercourse two miles south of the village.

These pigeons fed on acorns and to a considerable extent on wild grapes (*Vitis Berlandieri*). Thirty-four of the latter were found in the crop and gizzard of a single bird. Fully developed eggs were found in specimens collected by Fautin late in July.

Scardafella squamata inca Lesson

Apatzingan: 1 male, 1 female, August 9 and 23.

Cerro de Tancítaro: 3 males, 1 female, July 5–30.

Inca doves abounded in the Apatzingan area but were most numerous in the semi-arid thorn forest. On the plateau they were restricted principally to livestock corrals, where they fed on the seeds in cow manure.

Columbigallina passerina pallescens Baird

Apatzingan: 1 male, August 13.

This species was the least common of the three small doves found in the tierra caliente.

Columbigallina talpacoti eluta Bangs

Apatzingan: 3 males, July 31–August 14.

Leptotila verreauxi angelica Bangs and Penard

Apatzingan: 1 female, August 8.

Ara militaris mexicana Ridgway

Apatzingan: 1 male, 1 female, August 10.

Aratinga canicularis eburnirostrum Lesson

Apatzingan: 2 males, August 8.

This paroquet and macaws were more numerous than the other parrots of the lowland forests near Apatzingan.

All species fed principally upon wild figs during August when observations were made.

Rhynchopsitta pachyrhyncha Swainson

Cerro de Tancítaro: 3 males, July 4–22.

Thick-billed parrots occurred at random in the Cerro de Tancítaro area from the lowlands to the highest reaches of the mountain. They were moderately abundant in the tropical deciduous forest. Observations by both expeditions indicate that daily flights are made to the pine forests of the higher slopes for piñon nuts each morning and evening. The occurrence of thick-billed parrots in the Cerro de Tancítaro area constitutes, as far as we are aware, the first record for Michoacan and represents a considerable southwestern extension of range.

In addition to piñon nuts, the fruit of a local cherry tree (*Prunus Capuli*) was eaten, and one specimen contained seeds of an undetermined leguminous plant.

Amazona finschi finschi Sclater

Apatzingan: 2 females, August 9 and 13.

Finsch's parrots congregated in large flocks in the deciduous forest near Apatzingan but were not seen elsewhere.

Piaya cayana mexicana Swainson

Apatzingan: 3 females, 1 male, August 7–20.

Squirrel cuckoos were restricted to lowland forested areas, where their skulking habits permitted only occasional observation.

A stomach which was examined contained four small lepidopterous larvae, the chitinous remains of a beetle, and fleshy parts of a small fruit.

Crotophaga sulcirostris sulcirostris Swainson

Apatzingan: 1 male, August 9.

Geococcyx velox melanchima Moore

Acahuato: 1 female, August 17.

A specimen collected in the chaparral between Acahuato and Apatzingan, at an altitude of 2,000 feet, agrees in all salient characters with two birds from Tuxpan, Jalisco. The affinities of roadrunners from the highlands of Michoacan are not known with certainty, but they may be expected to show some degree of intergradation with *velox* of east-central Mexico.

Suitable plant associations rather than altitude apparently control the local distribution of this species. Members of the 1940 expedition saw an immature captive bird which had been taken on the northern side of the mountain in an area of open, mixed forest. In July of the following year Robert Traub observed a roadrunner at 8,000 feet altitude on Cerro de Tancítaro at the edge of a corn field and the upper limits of the cloud forest.

Tyto alba pratincola Bonaparte

Apatzingan: 1 male, August 5.

Otus trichopsis trichopsis Wagler

Tancítaro: 1 female, August 14.

A single specimen of spotted screech owl, representing an extreme rufous phase, was taken on the plateau at an altitude of approximately 6,500 feet. Specimens in comparable plumage are uncommon in collections and those available exhibit a marked diversity of

pattern. Two Jalisco birds examined (Amer. Mus. Nat. Hist. Nos. 105339, 105340) are more streaked above, lighter below and more barred generally than the Tancítaro specimen. The latter is more intensely rufous below with heavier black streaks totally lacking in crossbars. The measurements are wing 142, tail 67.

Spotted owls are nocturnal and largely insectivorous. The remains of four beetles (Scarabaeidae), a roach (Blattidae) and two indeterminate insect larvae constituted the stomach contents of the Tancítaro specimen.

Bubo virginianus mayensis Nelson

Tancítaro: 1 male, July 8.

Glaucidium minutissimum[1] gnoma Wagler

Cerro de Tancítaro: 2 males, 3 females, June 28–August 3.

Two specimens of the intermediate phase and three of the gray phase collected on Cerro de Tancítaro are in immature plumage. The grayish-brown pileum of each is more or less spotted with whitish on the forehead and contrasts sharply with the uniformly brown back. An interesting progression of plumage is discernible in this small series. Two specimens collected in June are almost devoid of forehead spotting but have their sides and breasts so heavily washed with rich, unmarked brown as to encroach upon the streaked under parts. July specimens exhibit increased spotting of the pileum coincident with a vague spotting on the sides of the breast. A single specimen collected August 3 approaches adult plumage in having the pileum and sides of the breast more strongly spotted than in those birds taken earlier and the pileum is less sharply defined from the unmarked back. All five specimens have either six or seven tail-bars.

Pygmy owls apparently occur only at the higher elevations on Cerro de Tancítaro, the present series being collected between 6,200 and 10,800 feet altitude.

Two stomachs were examined, one containing small portions of undetermined beetles and the other the remains of a small skink (*Eumeces*).

Ciccaba virgata squamulata Bonaparte

Apatzingan: 1 female, August 10.

[1] The apparent conspecificity of *gnoma* and *minutissimum* has been clarified by Griscom (1931), whose nomenclature we adopt.

Nyctibius griseus mexicanus Nelson

A specimen collected by natives near Tancítaro was examined by Joel Canby, mammalogist of the 1940 expedition, but unfortunately was not preserved.

Nyctidromus albicollis yucatanensis Nelson

Apatzingan: 1 female, 1 male, August 2 and 14.

Aëronautes saxatalis nigrior Dickey and van Rossem

Cerro de Tancítaro: 4 males, 2(?), July 29–August 13.

White-throated swifts from Cerro de Tancítaro are readily separable from specimens of the northern race on the basis of characters designated by Dickey and van Rossem in their description of the present form. No evidence of intergradation with *A. s. saxatalis* is apparent in our series although the two races are said to merge in central Mexico.

A flock of about thirty swifts inhabited the ruins of an old Spanish cathedral at the edge of Tancítaro and young birds were captured by natives late in June and during the early part of July. Small flocks of adult swifts were frequently observed in flight above the plateau and upward to the summit of the mountain. None were reported below 4,000 feet altitude.

Saucerottia beryllina viola Miller

Tancítaro: 4 males, 4 females, 1(?), June 25–July 30.

This was the most abundant humming bird on the plateau. The orange blossoms of an epiphyte (*Psittacanthus calyculatus*) were its primary source of food during the period of observation, and trees which bore this growth were almost invariably frequented by several individuals.

Cynanthus latirostris propinquus Moore

Apatzingan: 1 male, August 12.

The single specimen available from the Cerro de Tancítaro area indicates some degree of intergradation with *magicus* but must be referred to *propinquus* on the basis of its much bluer posterior under parts, darker and less golden green upper parts and absence of any conspicuous break in coloration between the throat and jugulum. Its relationship to *propinquus* apparently is similar to that of the three specimens from Lake Cuitzeo, Michoacan, discussed by Moore (1939a, pp. 57–58). Three males from Guaracha, a locality

between Zamora and Lake Chapala, which we have examined, are similarly intermediate.

Hylocharis leucotis leucotis Vieillot

Cerro de Tancítaro: 4 males, 3 females, June 23–July 30.

White-eared humming birds occurred on the plateau but, like the following species, were more abundant in the yellow pine–bunch grass association above 10,000 feet altitude, where the flowering lupine (*Lupinus persistens*) was a common source of food. At lower elevations both species resorted to the orange blossoms of an epiphyte (*Psittacanthus calyculatus*).

Cyanolaemus clemenciae clemenciae Lesson

Cerro de Tancítaro: 3 males, 4 females, June 29–July 24.

Lampornis amethystinus brevirostris Ridgway

Cerro de Tancítaro: 1 male, 1 female, July 11 and August 1.

Trogonurus mexicanus Swainson

Cerro de Tancítaro: 4 males, 1 female, July 2–19.

Mexican trogons were observed with about equal frequency in a dense pine forest at 6,500 feet altitude and in the damp, epiphyte-festooned cloud forest. They are distinctly birds of the forest crown, seldom being seen less than thirty or forty feet above the ground. During the early morning hours the males, particularly, often seek exposed perches well above the forest crown.

Trogons are largely insectivorous but one stomach which was examined contained the remnants of a small fruit in addition to a large lepidopterous larva and the elytra of a beetle.

Trogon citreolus Gould

Apatzingan: 3 males, 2 females, August 6–22.

Megaceryle torquata torquata Linnaeus

Apatzingan: 1 male, August 14.

Chloroceryle amazona Latham

Apatzingan: 1 female, August 12.

Chloroceryle americana septentrionalis Sharpe

Apatzingan: 2 males, 1 female, August 7–21.

Momotus mexicanus mexicanus Swainson

Apatzingan: 1 male, 2 females, August 7–18.

The three birds collected at Apatzingan are indistinguishable from Jalisco specimens which we have examined and may be matched equally well by a series from Guerrero and Oaxaca. Continued recognition of a supposedly larger and deeper-colored race (*saturatus*) of Michoacan, Guerrero, Oaxaca, and Chiapas is insupportable in the absence of constant and geographically correlated characters.

Colaptes cafer mexicanus Swainson

Cerro de Tancítaro: 1 male, 4 females, July 17–22.

This well-marked race of red-shafted flicker shows little preference in its altitudinal range. It avoids the lowlands but individuals were collected or seen from the plateau upward to 11,000 feet on Cerro de Tancítaro.

Ants constitute a considerable portion of this flicker's diet but miscellaneous larvae and the chitinous remains of beetles were also found in three of the four stomachs examined.

Centurus chrysogenys flavinuchus Ridgway

Apatzingan: 4 males, 1 female, August 8–13.

Balanosphyra formicivora formicivora Swainson

Cerro de Tancítaro: 3 males, 3 females, July 20–August 5.

Ant-eating woodpeckers were among the most conspicuous elements in the bird life of Cerro de Tancítaro. They were particularly abundant on the plateau, but also ranged upward in the pine forest to an elevation of about 9,000 feet. In the latter habitat their activities were generally confined to the upper portions of the large pines.

Grit was conspicuous in all five stomachs examined, twenty-two pieces being counted in a single specimen. On the plateau these woodpeckers were seen feeding on a large variety of choke-cherry (*Prunus Capuli*), but miscellaneous insects were also included in the stomach contents.

Phloeoceastes guatemalensis nelsoni Ridgway

Apatzingan: 2 males, August 1 and 16.

Dryobates villosus jardinii Malherbe

Cerro de Tancítaro: 5 males, 1 female, June 25–August 6.

Hairy woodpeckers occurred at random from the plateau upward to 11,300 feet on Cerro de Tancítaro, but were most numerous in areas of deciduous forest.

Insect larvae apparently constitute the principal food of this species, for a single pupa was the only exception found in the three stomachs examined.

Dryobates scalaris azelus Oberholser

Cerro de Tancítaro: 1 male, 2 females, August 5 and 6.

Dryobates arizonae fraterculus Ridgway

Tancítaro: 1 female, July 26.

Xiphorhynchus flavigaster mentalis Lawrence

Apatzingan: 1 male, August 14.

Lepidocolaptes leucogaster leucogaster Swainson

Tancítaro: 2 males, 3 females, 2(?), June 27–August 5.

White-striped woodhewers apparently were restricted to the plateau where they occurred with equal abundance in the unmixed stands of pine forest and in the pine–oak association near Tancítaro. The specialized feeding habits of this woodhewer limit its activities to the lower portions of tree trunks, which are seldom ascended above twenty-five feet.

Miscellaneous insects and chitinous parts of small beetles composed the bulk of the four stomach contents examined.

Attila spadiceus pacificus Hellmayr

Apatzingan: 1 female, August 15.

Tancítaro: 1 male, July 26.

Tyrannus vociferans vociferans Swainson

Tancítaro: 1 male, August 15.

The reduced measurements (wing 116, tail 80, culmen 16) and immature plumage of this specimen suggest that Cassin's kingbird breeds in Michoacan.

Tyrannus melancholicus occidentalis Hartert and Goodson

Apatzingan: 1 male, August 11.

Tyrannus crassirostris crassirostris Swainson

Apatzingan: 1 female, 1 male, August 13 and 15.

Myiodynastes luteiventris luteiventris Sclater

Apatzingan: 1 male, 1 female, August 10 and 15.

Pitangus sulphuratus derbianus Kaup

Apatzingan: 2 males, July 12 and August 18.

Myiarchus tuberculifer querulus Nelson

Apatzingan: 2 females, August 13 and 15.

Cerro de Tancítaro: 1 male, 2 females, June 27–July 23.

Birds from the Cerro de Tancítaro area are indistinguishable from four specimens of *querulus* collected at Tuxpan, Jalisco, and Iguala, Guerrero.

Querulous flycatchers have been recorded in the mountains as well as lowlands of Michoacan (Los Reyes, Ahuacana, Patzcuaro, Apatzingan, and Cerro de Tancítaro) and may be regarded as the resident race.

Myiochanes pertinax pertinax Cabanis and Heine

Acahuato: 1 male, August 20.

Apatzingan: 1 female, August 7.

Cerro de Tancítaro: 3 males, 1 female, July 28–August 5.

This pewee occasionally occurs in the lowlands but throughout its range it is primarily a bird of the mountains. It was usually associated with the open pine groves of the plateau.

Empidonax minimus Baird

Apatzingan: 1 female, August 12.

Empidonax difficilis occidentalis Nelson

Cerro de Tancítaro: 3 males, 2 females, 2(?), July 6–25.

Two unsexed specimens collected on the plateau and at 10,200 feet altitude July 20 and July 25 respectively are in immature plumage and probably came from nests in the vicinity. On the basis of data now available we agree with Moore (1940, p. 28) that the breeding birds of southern Mexico should be referred to this race.

Our field records for this flycatcher include elevations from 6,000 to 10,600 feet. There is no evidence that it discriminates between plant associations, for specimens were collected in such widely divergent habitats as the cloud forest and the pine–oak association.

Empidonax fulvifrons rubicundus Cabanis and Heine

Cerro de Tancítaro: 2 males, 1 female, June 27 and August 5.

Ruddy flycatchers were most frequently seen in open, grassy areas on the plateau where they perched on low shrubs and weed stems a foot or two above the ground.

One specimen had eaten a small orthopteron, two beetles, a weevil and a hymenopteron. A second stomach examined contained an unidentified dipteron and considerable chitinous débris.

Mitrephanes phaeocercus phaeocercus Sclater

Cerro de Tancítaro: 3 males, 2(?), June 26–August 5.

Michoacan and Morelos constitute an area of intergradation between *phaeocercus* and *tenuirostris* Brewster, but birds from the Cerro de Tancítaro area are unquestionably more closely related to the former.

Unlike the last species, this flycatcher usually selects exposed perches on the treetops from which to dart out on short flights for insects.

Hirundo rustica erythrogaster Boddaert

Cerro de Tancítaro: 2 males, July 19 and 24.

Although the available evidence is not conclusive, it is probable that additional observations will definitely establish the barn swallow as a breeding species in Michoacan. Both specimens listed above have the short tail and somewhat dull plumage of birds of the year, but admittedly were capable of strong flight.

Iridoprocne albilinea albilinea Lawrence

Cerro de Tancítaro: 1 female, June 27.

The occurrence of a single immature specimen of this typically coastal species far inland is most surprising. The Rio Tepalcatepec could have served as a natural route of migration from the lowlands.

Corvus corax sinuatus Wagler

Cerro de Tancítaro: 1 male, August 15.

Ravens were fairly abundant up to 6,000 feet but were most numerous below in arid areas of sparse vegetation.

A well-packed stomach which was examined contained Scarabaeidae (75 per cent), fifty-three seeds of a grape (*Vitis*) and a few kernels of corn.

Calocitta formosa formosa Swainson

Apatzingan: 1 male, 1(?), August 3 and 9.

Magpie-jays were observed only in the semi-desert scrub association near Apatzingan. A stomach which was examined contained 80 per cent vegetable matter in the form of small seeded fruits and 20 per cent miscellaneous insect bits.

Aphelocoma sordida sieberii Wagler

Cerro de Tancítaro: 4 males, 2 females, July 14–28.

The local distribution of Sieber's jay, unlike that of the following species, coincides with the distribution of pine forests to which it is restricted. A bold and raucous bird wherever found, this jay ranged from the plateau up to approximately 11,000 feet.

An unidentified nut was the predominant food in four of the stomachs examined. One bird had also eaten a nestling of uncertain identification. A fifth stomach contained only the remnants of miscellaneous insects.

Cyanocitta stelleri coronata Swainson

Cerro de Tancítaro: 2 males, 4 females, July 6–26.

Two races of the present species undoubtedly intergrade in Michoacan. Ridgway has called attention to specimens from Patzcuaro which indicate, in slightly reduced size and increased blueness of the crest, a definite trend towards *C. s. coronata.* Cerro de Tancítaro birds show a progression of this tendency and may be considered to occupy a position practically intermediate between that race and *C. s. azteca.* No clear picture can be gained from the measurements of our small series but a closer affinity with *C. s. coronata* is indicated by an evaluation of other characters. A striking feature of the Cerro de Tancítaro specimens, which we have not found in birds from other localities, is the considerable reduction of the white patch over the eye and absence of a white spot on the lower eyelid.

Blue-crested jays were restricted almost exclusively to the cloud forest, although one specimen was collected in the upper pine–oak association.

Parus sclateri sclateri Kleinschmidt

Cerro de Tancítaro: 5 males, 2 females, July 2–31.

Mexican chickadees were abundant in the pine forests at all altitudes above 3,000 feet. It is remarkable that this active species has not been reported in Michoacan before.

Psaltiparus minimus melanotis Hartlaub

Cerro de Tancítaro: 1 female, August 6.

A band of approximately twenty-five black-eared bush-tits ranged over an area of scattered bushes and small deciduous trees on the plateau.

Sitta carolinensis mexicana Nelson and Palmer

Cerro de Tancítaro: 2 males, 2 females, August 5 and 16.

Additional specimens of *carolinensis* are needed from Michoacan to determine accurately the status of Cerro de Tancítaro birds. In size, as well as geographically, the specimens listed above lie between *kinneari* and *umbrosa*, recently described by van Rossem. All measurements equal or exceed the maximum of the former but only partially satisfy the minimum requirements of the latter. Cerro de Tancítaro specimens are very slightly lighter above than *umbrosa* and in this respect resemble *mexicana*. It is probable that an adequate series of birds from this area will indicate the presence of an intermediate population linking the latter races, but not sufficiently differentiated for subspecific designation.

White-breasted nuthatches were restricted to the plateau where they were fairly abundant in the pine–oak forest. Nesting apparently ended early in July, for family groups were observed by the middle of the month.

Sitta pygmaea flavinucha van Rossem

Cerro de Tancítaro: 4 males, 4 females, July 17–21.

Unlike the last species, pygmy nuthatches were strictly limited to the pine forests of the upper slopes. One specimen was collected at 9,000 feet, but seven others were taken above 11,000 feet in the pine–bunch grass association.

Certhia familiaris guerrerensis van Rossem

Cerro de Tancítaro: 2 males, 3 females, July 19–August 5.

We have not had an opportunity to examine creepers from Jalisco but no significant difference can be found between our small series and four specimens from the Sierra Madre del Sur, Guerrero. Hellmayr includes Michoacan in the range of *alticola* but Cerro de Tancítaro specimens are readily separable on the basis of their smaller size (males: wing 60–63, tail 59–60, culmen 13–16) and much darker under parts.

Creepers occurred at all elevations, from the plateau to approximately 11,000 feet. They were fairly abundant in most zonal associations but none were found in the cloud forest.

Cinclus mexicanus mexicanus Swainson

Cerro de Tancítaro: 2 females, 1(?), July 3 and 7.

An examination of a large series of Mexican dippers collected over a period of years reveals a degree of plumage-fading not sufficiently emphasized heretofore. In very old skins the plain sepia of the head and neck becomes a dull brown wash which extends over and practically replaces the original clear slate color of the back. Consequently, no line of color demarcation between the neck and back remains. Some fading is to be expected under the best conditions of storage, but few birds deteriorate as rapidly in this respect as dippers. Among relatively fresh skins it is possible, on the basis of fading, to separate those collected at intervals of only two years. Therefore, consideration of probable new races of *mexicanus* should always be made on the basis of comparison with specimens of comparable age.

Dippers were restricted to the fast-flowing canyon streams of the cloud forest.

Heleodytes megalopterus megalopterus Lafresnaye

Cerro de Tancítaro: 4 males, 5 females, 1(?), June 28–July 26.

This cactus wren was seen only in the cloud forest. A band of nine individuals, probably constituting a single family, was frequently observed during the last week of July near a camp maintained at 8,500 feet. Their feeding activities extended from the forest floor to the mid-portions of the higher trees, but epiphytic plants were explored with particular energy. During the post-breeding season this wren becomes relatively furtive and silent but occasionally startles one with its characteristic rattling din.

Heleodytes gularis Sclater

Tancítaro: 3 males, August 7 and 16.

Some recent authors prefer to regard *gularis* and *jocosus* as conspecific on the basis of the relatively minor differences which are observable in the adults. This view is untenable, however, if one properly evaluates the genetic implications suggested by the strikingly dissimilar immature birds. These are no less important than adults in indicating relationships, and the origins of respective popu-

lations. In the light of modern genetics certain basic differences, including the presence of ventral spotting in *jocosus*, and its absence in immature specimens of *gularis*, indicate the introduction (or loss) of genetic characters so distinct as to belie the fortuitous resemblance of the adults. We do not hesitate to grant *gularis* specific rank.

Thryothorus pleurostictus nisorius Sclater

Apatzingan: 4 males, 1 female, August 10–23.

Thryomanes bewickii percnus Oberholser

Tancítaro: 1 male, 2 females, July 18–31.

The large size (male: wing 62, tail 61, culmen 15) and dark coloration of Tancítaro specimens readily distinguish them from *murinus* of south-central Mexico. Jalisco wrens have not been recorded from Michoacan before, but a straggler was collected at Puente Colorado, Puebla, on August 3, 1868, by Professor Sumichrast.

Troglodytes brunneicollis colimae van Rossem

Cerro de Tancítaro: 6 males, 4 females, June 30–July 28.

Our series of fresh breeding specimens agrees in all intrinsic characters with a December male from the type locality. This well-defined race apparently is a bird of the higher mountains. A single specimen was observed on the plateau but these wrens were most abundant in the pine–bunch grass association above 10,000 feet altitude.

Henicorhina leucophrys festiva Nelson

Cerro de Tancítaro: 1 male, July 31.

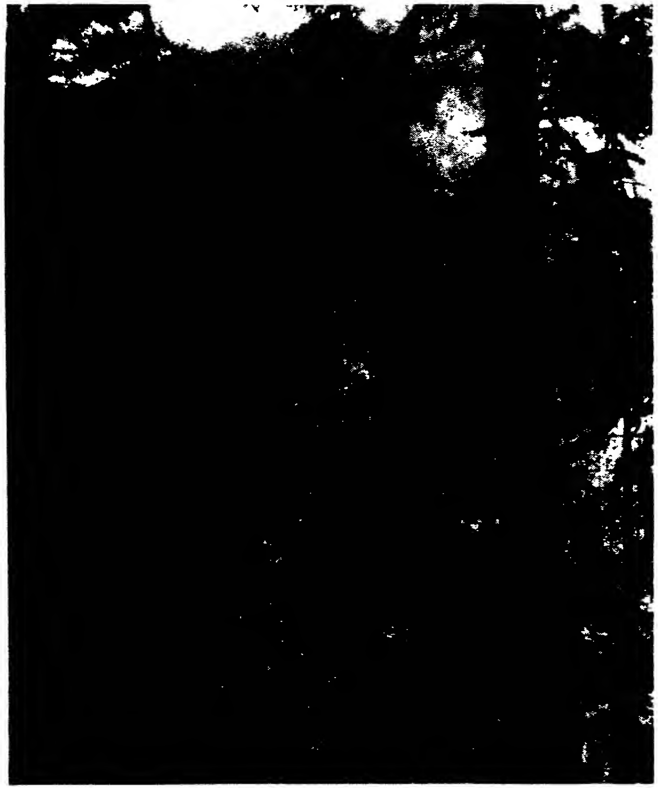
Wood wrens are among the best indicators of the Humid Upper Tropical Zone. They occurred only in the cloud forest on Cerro de Tancítaro and were excessively difficult to observe in the low shrubs and ground cover which constituted their principal habitat. The song of this species compares favorably in strength and clarity of tone with that of any other wren and frequently was the first or only indication of its presence.

Catherpes mexicanus mexicanus Swainson

Canyon wrens inhabited the ridges of volcanic rock and old stone fences on the plateau, but unfortunately none were collected by either expedition.

Toxostoma curvirostre curvirostre Swainson

Tancítaro: 3 males, 1 female, 2(?), June 24–August 3.



FIR FOREST
Altitude about 9,000 feet

CLOUD FOREST OF HUMID UPPER TROPICAL ZONE
Altitude about 7,500 feet

1

2

3

TEMPERATE ZONE OF CERRO DE TANCÍTARO

Fig. 1. Open pine, with high bunch grass; altitude 10,000 feet. Fig. 2. Fir-alder forest, upper limit of cloud forest. Fig. 3. Open pine forest, Tancítaro plateau; altitude about 4,500 feet.

The roadside thickets of agave, thorny bushes, and small trees on the plateau were the favorite habitat of the curve-billed thrasher.

Two stomachs which were examined contained several curculionid beetles, a cricket, undetermined larvae, and numerous fine seeds.

Melanotis caerulescens effuticus Bangs and Penard

Tancítaro: 1 male, 4 females, July 30–August 5.

Griscom refers specimens from Chilpancingo, Guerrero, to the present race but states (1934, p. 396) that they are slightly gradient toward *caerulescens* of eastern and south-central Mexico. Our birds show no divergence from typical *effuticus*, however, and are indistinguishable from a series of ten Jalisco and Nayarit specimens with which they have been compared.

The habitat of the blue mockingbird is similar to that of the curve-billed thrasher. It is a shy and elusive bird and apparently is restricted to the plateau, where trailside thickets and drainage ditches are particularly favored. Singing perches are usually selected in the upper parts of densely foliated trees so that detailed observation is impossible. This species is a versatile songster and has a repertoire somewhat reminiscent of the catbird.

A quantity of small berries, wild grapes, a lepidopterous larva, a small wasp, and a beetle were found in the three stomachs examined.

Turdus migratorius permixtus Griscom

Acahuato: 1 female, August 17.

Tancítaro: 3 males, 1 female, June 30–August 5.

Breeding specimens of *migratorius* from the Cerro de Tancítaro area agree in small size and dark coloration with the birds of Guerrero. The known range of *permixtus* is thus extended northwestward by more than two hundred miles.

Turdus rufo-palliatus rufo-palliatus Lafresnaye

Apatzingan: 1 female, 1 male, August 12 and 15.

Turdus assimilis renominatus Miller and Griscom

Apatzingan: 1 male, August 15.

Cerro de Tancítaro: 1 male, July 6.

Myadestes obscurus occidentalis Stejneger

Cerro de Tancítaro: 2 males, 3 females, July 15–August 16.

Pine-forested ridges and underbrush of the higher mountain slopes are the usual habitat of this remarkable songster. Solitaires were not observed above 8,000 feet but they were fairly numerous in suitable situations at lower elevations.

Catharus occidentalis fulvescens Nelson

Cerro de Tancítaro: 4 males, 2 females, July 2–27.

Members of this genus are among the wariest of tropical birds. The present species finds optimum conditions in the decaying vegetation, rank undergrowth, and other ground cover of the cloud forest and thus occupies a niche filled by the following species on the plateau.

Catharus aurantiirostris clarus Jouy

Tancítaro: 2 males, 3 females, June 27–August 5.

Sialia mexicana australis Nelson

Cerro de Tancítaro: 4 males, 3 females, July 20–August 16.

Nelson's bluebirds were most abundant in the pine–oak association on the plateau but three specimens were collected in the open pine forest above 11,000 feet altitude. A specimen taken on July 20 had left its nest not more than ten days before.

Polioptila plumbea bairdi Ridgway

Apatzingan: 2 males, August 18 and 24.

Regulus regulus clarus Dearborn

Cerro de Tancítaro: 1 female, June 29.

The single immature specimen collected in the cloud forest apparently constitutes the first specific record of a kinglet in Michoacan. In the absence of breeding adults from this area we assign this bird to *clarus* with reservations.

Ptilogonys cinereus pallescens Griscom

Cerro de Tancítaro: 3 males, 1 female, July 22–August 17.

Our small series, in molting and worn plumage, differs from specimens of *cinereus* collected in Vera Cruz and Mexico and may be regarded as intermediates. They appear to be nearer *pallescens* of Guerrero but an adequate series from Cerro de Tancítaro is needed to determine the actual relationship.

There seems to be no previous record of silky flycatchers in Michoacan. They occurred on the plateau in wandering bands of five or six individuals.

Vireolanius melitophrys melitophrys Du Bus

Cerro de Tancítaro: 1 female, June 30.

The occurrence of a shrike-vireo in Michoacan, almost two hundred miles distant from the nearest previous record, is most unexpected. Subspecific determination has been made arbitrarily in the absence of satisfactory comparative material.

Vireo huttoni mexicanus Ridgway

Tancítaro: 2 females, July 16 and 17.

Vireo bellii medius Oberholser

Apatzingan: 1 female, August 13.

Bell's vireo winters over the greater part of Mexico but there is no previous record of the occurrence of *medius*, an excellently differentiated race, south of Guanajuato.

Vireo solitarius repetens van Rossem

Tancítaro: 1 female, August 7.

The proportions (wing 82, tail 57) of our Michoacan specimen agree with those of Guerrero birds. It is further distinguished from a series of Arizona specimens (*plumbeus*) by its much greener flanks, back, and rump and hence may be regarded as a typical example of the long-winged, short-tailed race (*repetens*) reported heretofore only from Jalisco, Guerrero, and Oaxaca.

Vireo virescens flavoviridis Cassin

Apatzingan: 2 females, August 13 and 14.

Vireo gilvus subsp.

Tancítaro: 1 female, July 26.

The worn plumage and unsatisfactory condition of this specimen preclude accurate subspecific determination. Its measurements (wing 74, tail 52, culmen 11) conform with those of *brewsteri* and of the nominate race but the clear brown pileum and upper back are unlike any examples of the species which we have seen. Early migrants could reach Michoacan late in July but it is more likely that a large, brownish resident race exists there.

Diglossa baritula baritula Wagler

Tancítaro: 2 males, 1 female, June 23 and August 7.

Mniotilta varia Linnaeus

Tancítaro: 1 male, August 7.

Vermivora superciliosa palliata van Rossem

Cerro de Tancítaro: 4 males, 1(?), July 3–29.

The grayer (less greenish) flanks and generally paler coloration distinguish Cerro de Tancítaro specimens from a series of *mexicana* at our disposal. The extent of the yellow abdominal area, considered important by van Rossem, is so complicated by the "make" of individual skins that we find it useless as a diagnostic character.

All races of this species are birds of the highlands. On Cerro de Tancítaro it was most abundant in the open pine forest and pine-alder association above 8,000 feet altitude.

Compsothlypis pitiayumi pulchra Brewster

Apatzingan: 1 male, August 19.

Our single Michoacan specimen, in worn plumage, is somewhat darker (duller) above than typical examples from Sonora, but otherwise agrees with *pulchra* in all diagnostic characters. There is no previous record of this well-marked race south of Jalisco (Barranca Ibarra), so its status in Michoacan is uncertain.

Peucedramus olivaceus olivaceus Giraud

Cerro de Tancítaro: 5 males, 1 female, 2(?), July 17–August 7.

The variability of this species has been demonstrated by Miller and Griscom (1925, pp. 8–11) but their recognition of a supposedly small western race, *jaliscensis*, seems unjustified in the absence of a reasonably stable character. Specimens from Jalisco are said to differ from typical *olivaceus* only in size, being (male) wing 72–76, tail 51.1–53, culmen 10–10.6. However, the wings of ten males (*olivaceus*) from Cofre de Perote, Vera Cruz, measured by Hellmayr, varied from 74–78 mm. Theoretically, Michoacan lies well within the range of *jaliscensis*, but the measurements of our five males (wing 76–77, tail 51–54, culmen 10–11) undermine still further the concept of a distinct western race.

Olive warblers occurred in open pine forests from the plateau to the summit of Cerro de Tancítaro. They were most abundant at higher altitudes in the yellow pine-bunch grass association.

Dendroica occidentalis Townsend

Tancítaro: 1 male, 1 female, August 16.

Myioborus miniatus miniatus Swainson

Cerro de Tancítaro: 4 males, June 28–July 30.

All races of *miniatus* are excellent indicators of the Humid Upper Tropical Zone. The shrubs and undergrowth within pine forests of the plateau generally harbored this species and a few individuals were noted as high as 8,200 feet altitude, near the upper limits of the pine-alder-fir association.

Ergaticus ruber ruber Swainson

Cerro de Tancítaro: 4 males, 3 females, 1(?), July 6–25.

Red warblers are resident in the coniferous forests between 8,000 and 9,600 feet altitude.

Basileuterus belli clarus Ridgway

Cerro de Tancítaro: 1 male, 4 females, June 28–July 31.

No conclusive evidence that Cerro de Tancítaro birds differ intrinsically from typical *belli* can be found in the limited comparative material at our disposal. However, Wetmore's review of the species (1941, pp. 572–573) indicates the necessity of correlating individual color range with seasonal variation in evaluating racial distinctions, so we have accepted his determination of Michoacan birds.

This active warbler was restricted to the cloud forest, where it seldom ventured from the dense vegetation of the forest floor.

Cassiculus melanicterus Bonaparte

Apatzingan: 3 males, 1 female, August 11–18.

Mexican caciques were concentrated in the tropical deciduous forest and among the large trees in the irrigated country south of Apatzingan.

Cassidix mexicanus mexicanus Gmelin

Apatzingan: 1 female, August 13.

Tancítaro: 1 female, August 17.

A distinctly smaller form (*obscurus*) inhabits the coast district of western Mexico from Nayarit and Colima south to Guerrero. It has not been recorded in Michoacan specifically but undoubtedly supersedes the present race southwest of the Cerro de Tancítaro

area. The demarcation between the ranges of *obscurus* and *mexicanus* is not known in detail but certainly altitude is not an isolating factor. The former occurs on the coast and also at Chilpancingo, Guerrero, approximately 4,000 feet above sea level, and the latter has a vertical distribution no less extensive.

Icterus spurius Linnaeus

Apatzingan: 2 males, 1 female, August 12 and 23.

Icterus wagleri wagleri Sclater

Acahuato: 1 male, August 17.

Icterus pustulatus pustulatus Wagler

Apatzingan: 5 males, 4 females, August 9–21.

Scarlet-headed orioles from Apatzingan agree with an excellent series of Guerrero birds in Field Museum and give no indication of gradation toward *microstictus* as might be expected.

Tanagra musica elegantissima Bonaparte

Tancítaro: 1 male, June 23.

Piranga flava hepatica Swainson

Tancítaro: 4 males, July 22–August 6.

Piranga bidentata bidentata Swainson

Tancítaro: 2 males, 1 female, July 17–August 6.

Swainson's tanager is a subtropical form which, like the preceding species, was noted only in the open pine groves and pine-oak forests on the plateau.

Hedymeles melanocephalus maculatus Audubon

Tancítaro: 3 males, 2 females, June 24–August 6.

Passerina versicolor subsp.

Apatzingan: 2 males, August 12 and 13.

Our specimens from the semi-desert scrub area near Apatzingan agree in size (wing 64, tail 50–53) with *purpurascens* of Guerrero, Morelos, and Guatemala but are in such worn plumage that subspecific determination is impractical. There are no data on the breeding population, but Michoacan lies within the migration range of the nominate race, and adjoins that of *dickeyae* and *purpurascens*, so exceptional care should be exercised in identifying all specimens from that state.

Passerina leclancherii leclancherii Lafresnaye

Apatzingan: 2 males, August 10 and 24.

Hesperiphona abeillei abeillei Lesson

Cerro de Tancítaro: 1 male, July 8.

Abeille's grosbeak is a bird of the highlands, known heretofore only from the states of Mexico(?), Vera Cruz, Puebla, and Oaxaca. The Michoacan specimen is in immature plumage and represents an unexpected westward range extension of more than two hundred miles.

Carpodacus mexicanus coccineus Moore

Tancítaro: 7 males, 3 females, June 23–August 7.

The taxonomy and relationships of house finches in Mexico have been clarified in several recent papers by Moore, who regards Patzcuaro (Michoacan) specimens as intergrades between the present race and *centralis* of Guanajuato. It follows that Tancítaro birds are similarly intermediate. Five adult males from the plateau are indistinguishable in appearance from a series from Tuxpan, Jalisco, but approach *centralis* in size; wing 81–82, tail 61–63.

Volatinia jacarina diluta van Rossem

Apatzingan: 3 males, August 11 and 20.

The characters which are said to separate *diluta* from *atronitens* of eastern Mexico and Central America are evident only in females, young males, and adult males in winter plumage. We have not seen sufficient Mexican specimens in these critical plumages to form an independent opinion on the advisability of recognizing a western race, but regard it with suspicion. The relationship between the grassquits of Mexico, Central America, and northern South America is not yet clear; in fact, interesting data presented by Hellmayr (1938, pp. 254–255) indicates so great a degree of individual variation and instability among these birds as to cast doubt on their subspecific divisibility.

Spinus pinus macropterus Bonaparte

Cerro de Tancítaro: 1 male, 1 female, July 21 and 24.

Pine siskins were restricted to the higher reaches of Cerro de Tancítaro, being most numerous in open pine forest above 10,000 feet.

Spinus notatus griscomi van Rossem

Tancítaro: 1 male, June 27.

Loxia curvirostra stricklandi Ridgway

Tancítaro: 2 males, 3 females, 1(?), June 25–August 5.

Mexican crossbills were observed only on the plateau in the pine-oak forest (4,500–6,000 ft. alt.) and in the vicinity of the village. Several specimens were collected near the cathedral. The absence hitherto of this species from the known fauna of Michoacan is further indication of the limited field work done in that state.

Atlapetes pileatus pileatus Wagler

Cerro de Tancítaro: 5 males, 2 females, 1(?), June 23–July 28.

This finch was abundant on the plateau and ranged upward at least to 8,600 feet.

Atlapetes torquatus virenticeps Bonaparte

Cerro de Tancítaro: 1 male, 3 females, 1(?), July 1–30.

Arremonops rufivirgatus sumichrasti Sharpe

Apatzingan: 1 male, 1 female, August 20.

Pipilo ocai[1] nigrescens Salvin and Godman

Tancítaro: 5 males, 2 females, 2(?), June 22–August 6.

The presence in Michoacan of a breeding population of towhees combining characters of *Pipilo ocai* and of *P. macronyx* has caused confusion for many years. Michoacan birds were first recognized as a distinct entity in 1889 by Salvin and Godman, who described *Chamaeospiza nigrescens* on the basis of a pair of specimens collected at Patzcuaro. Ridgway (1901, p. 408) accepted the specificity of *nigrescens* but advanced the opinion that it might prove to be merely the result of hybridization between the *Pipilo torquatus* (=*ocai*) and *P. macronyx* groups. In support of this view, subsequently adopted by most authors, Hellmayr (1938, p. 454) states that "eight specimens (from Michoacan, Vera Cruz, and Puebla) form an almost unbroken chain between *macronyx* and *torquatus*, and clearly indicate hybridization."

The close relationship between these species is evident. Some degree of hybridization between them undoubtedly occurs, but analysis of their present distribution refutes the concept that individual Michoacan specimens are fortuitous hybrids. No race of *macronyx* or of *ocai* other than *nigrescens* occurs in that state, nor

[1] Priority of *ocai* over *torquatus* has been established by van Rossem (1940, pp. 173–174).

have birds of the *nigrescens* type been found elsewhere. The latter are composite in appearance, and exhibit considerable individual variation of certain characters, but there is not the slightest difficulty in separating Michoacan specimens from all others.

In order to determine the affinities of this interesting form the authors assembled all available specimens from Michoacan (thirty-three) for direct comparison with eighty specimens representing all known races of *macronyx* and *ocai*. Michoacan birds (*nigrescens*) resemble the latter in general pattern but may be distinguished by the vestigial nature of their white gular patch and by the absence of a superciliary line. Of the thirty-three Michoacan specimens examined, three show no trace of white on the throat and only one adult, collected at Patamban in January, 1903 (No. 185076, coll. of the Fish and Wildlife Service), lacks the typical chestnut crown-patch of the *ocai* group. Obscure black dorsal streaks and a slightly cinnamomeous tinge on the under parts (flanks and under tail coverts) of certain Michoacan specimens may be regarded as further indication of their link with the *macronyx* group but in no case are these characters well developed, nor do Michoacan birds have spotted tails.

The composite appearance of Michoacan birds is due to multiple gene factors possibly acquired at a time when the ranges of *ocai* and *macronyx* overlapped in this area. Whatever the origin of *nigrescens*, it constitutes an isolated breeding population in Michoacan (Cerro de Tancítaro, Nahuatzin, Patamban, and Patzcuaro), separable in 100 per cent of the specimens examined, and hence must be regarded as subspecifically distinct. The distribution and composite appearance of *nigrescens* indicate a relationship between *P. ocai* and *P. macronyx* so close as to suggest that they are races of the same species. Complete revision of these forms is beyond the scope of the present report.

Pipilo fuscus fuscus Swainson

Tancítaro: 3 males, 4 females, 2(?), June 23–August 3.

Our series from Cerro de Tancítaro, which lies in an area generally conceded to be occupied by the nominate race, agrees in size and color with seven adult specimens collected in May at Tuxpan, Jalisco, only eleven miles south of Zapotlan, type locality of the recently described race *tenebrosus*. We have not seen Zapotlan specimens but it is evident that Mexican races of this species require careful revision before additional forms are described.

Brown towhees are among the most abundant birds on the plateau, being especially numerous in the village of Tancítaro and in the roadside thickets of the surrounding country. They probably have two broods during the season, as parents feeding full-grown young were frequently observed and on July 20 natives brought in a nest containing three half-grown fledglings.

Plagiospiza superciliosa superciliosa Swainson

Cerro de Tancítaro: 3 males, 4 females, 1(?), July 17–22.

Striped sparrows and pygmy nuthatches are the only birds which seem to be limited to the highest slopes of the mountain. All our specimens of the former were collected in the pine–bunch grass association above 10,200 feet.

Two stomachs which were examined contained leguminous seeds (probably *Lupinus*) and miscellaneous plant and insect débris.

Aimophila humeralis humeralis Cabanis

Apatzingan: 1 female, August 9.

This specimen agrees perfectly with a series from Iguala, Guerrero, and shows no tendency to intergrade with *asticta* of Colima.

Aimophila ruficauda acuminata Salvin and Godman

Apatzingan: 2 males, 1 female, August 11–19.

Junco phaeonotus australis van Rossem

Cerro de Tancítaro: 3 males, 2 females, 1(?), July 15–August 1.

These specimens are intergrades between *colimae* of Jalisco and *australis* of Guerrero but apparently are more closely related to the latter. They differ from a series of summer adults from Nuevo Leon (typical *phaeonotus*) in having somewhat browner flanks, darker upper parts and decidedly more extensive red on the tertials and lower back. Measurements of three males agree with those of *australis:* wing 76–78, tail 68–69.

Mexican juncos were found at all elevations from the plateau to near the summit of Cerro de Tancítaro wherever there were open fields or areas with herbaceous cover.

Spizella passerina mexicana Nelson

Tancítaro: 1 male, June 23.

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INDEX

Current names in roman type, synonyms and secondary references in *italic* type, new names in **bold-faced** type.